3. ENVIRONMENTAL SETTING

3.1 GEOLOGY

The NSMWA is located in California's geologically active Coast Ranges Geomorphic Province. The province is characterized by a series of northwest trending mountain ranges, valleys, and faults (Jones and Stokes 2004a, 2004b). The dominant geologic processes that have shaped the San Francisco Bay region are active faulting along the San Andreas, Hayward, and other faults; uplift and erosion of the east bay and peninsular hills; and subsidence of the San Francisco Bay basin. The San Francisco Bay region appears to be a pull-apart basin that has been continuously subsiding since late Quaternary time (the past 700,000 years) in response to local crustal subsidence between the San Andreas and Hayward faults. The stratigraphy beneath the San Francisco Bay region records changes in depositional environments resulting from changes in sea level. The primary geological units that underlie a large part of the San Francisco Bay region are the Alameda Formation, Old Bay Mud, San Antonio Formation, Young Bay Mud, and the Temescal Formation.

The Franciscan Formation basement was originally above sea level and exposed to dissection by rivers and streams (Jones and Stokes 2004a, 2004b; URS 2006a). As the basement began to subside between 1,000,000 and 500,000 years ago, the initial unit deposited on its surface was the Alameda Formation. Since the formation of the Sacramento-San Joaquin drainage outlet through San Francisco Bay approximately 400,000 years ago, the environment of deposition has fluctuated between estuarine (periods of high sea level resulting from a warm global climate) and alluvial (periods of low sea level during periods of cold global climate) (Sloan 1992).

The present Bay estuary formed less than 10,000 years ago as the global climate warmed and sea levels rose. Marine water reentered the Bay approximately 10,000 years ago and by about 4,000 years ago had reached its present level. With the establishment of true estuarine conditions, sedimentation in the Bay changed from alluvial sands and silts to dark-colored estuarine clays and silts, commonly called Bay Mud. Deposition of sandier sediment was confined to channels. Since about 1850, human activities have made enormous modifications to the Bay, causing changes in the patterns of circulation and sedimentation. Between 1856 and about 1900, hydraulic mining in the Sierra foothills deposited several feet of sediment throughout the Bay. Starting in the 1800s, the construction of levees and dikes altered the patterns of drainage and annual flooding in the Sacramento River delta. Also, the placement of fill at numerous localities around the Bay margins has dramatically altered the shoreline profile during historic time.

The entire NSMWA is underlain by varying thicknesses of Bay Mud, a soft compressible organic-rich marine deposit of silt and clay with peat and local, thin sand and gravel lenses (USACE 2004a; Jones and Stokes 2004a, 2004b). San Francisco Bay has two units of Bay Mud: Young Bay Mud is found closest to the surface, and Old Bay Mud (Yerba Buena Formation) is found below the non-marine deposits underlying the Young Bay Mud. Additional non-marine

deposits, including alluvial deposits, underlay the Old Bay Mud and also irregularly flank the margins of the Marshes. The hills that bound the Napa River Unit and the Napa and Sonoma Valleys are underlain by a variety of rock units, the most important of which are the Franciscan Formation (sandstone, shale, serpentine, and other rocks), the Chico Formation (mostly marine sandstone), the Merced Formation (Tertiary marine sands and sandstone), and the Sonoma volcanic (Tertiary volcanic flows and tuffs). The groundwater hydrology in the Napa Marsh area consists of aquifers of alluvial deposits of recent geologic age, supported by volcanic and continental deposits with low water yields.

3.2 SOILS

The soils found within the NSMWA are predominately the Reyes series (Wyckoff 2000), but soils from the Haire, Clear Lake, Cortina, and Rincon series are also found in the upland and transitional areas of NSMWA (**Figure 6**). Reyes soils are distributed throughout the site. Haire soils occur in the Huichica Creek, American Canyon, Southern Crossing, Ringstrom Bay and Napa River Units; Clear Lake soils occur in the Tolay Creek, Huichica Creek and South Crossing Units; Cortina soils occur in the Tolay Creek Unit; Rincon soils occur in American Canyon and White Slough Units. Levees in the Napa River Unit were constructed from the native Bay Muds and peat, and repaired using the same material (Camp Dresser & McKee 2000).

A brief description of each of soil series is provided below.

3.2.1 Reyes Series

The Reyes series consists of deep, somewhat poorly drained soils that formed in alluvium from mixed sources (NRCS 2004). Reyes soils are in reclaimed and protected marsh areas and have slopes of 0 to 2%. The soils formed in mixed bay and stream alluvium under marsh vegetation such as pickleweed, bulrush, and saltgrass. In the NSMWA, Reyes soils are typically found on tidal flats and marsh areas. These soils are silty clays deposited primarily by sediment-laden Bay waters, but also by tributary freshwater streams (Wyckoff 2000). The soil is acidic in its undeveloped state, its permeability is low, and the erosion hazard of these soils is not considered significant.

3.2.2 Haire Series

The Haire series is a member of the clayey, mixed, thermic family of Typic Haploxerults (NRCS 2004). Typically, Haire soils have gray and grayish brown, neutral or slightly acid, light clay loam A horizons, pale brown, strongly acid, clay B2t horizons, and pale yellow, strongly acid, gravelly clay loam C horizons. Haire soils are on nearly level to moderately steep hills at elevations of 20 to 2,400 feet. They formed in terrace deposits and in part in residuum weathered from arkosic sandstone and granodiorite. Haire soils are moderately well drained, and have slow to rapid runoff and very slow permeability.

Napa Sonoma Marshes Wildlife Area Land Management Plan

FIGURE 6

Soil Types within Management Units

- Alluvial Land, Clayey
- Clear Lake Clay Loam, 0 to 2 percent slopes
- Clear Lake Clay, 0 to 2 percent slopes
- Clear Lake Clay, overwashed
- Cortina Very Gravelly Loam
- Haire Clay Loam, 0 to 2 percent slopes
- Haire Clay Loam, 2 to 9 percent slopes
- Haire Loam, 0 to 2 percent slopes
- Haire Loam, 2 to 9 percent slopes
- Reyes Silty Clay Loam
- Reyes Silty Clay Loam, salt ponds
- Reyes Silty Clay, 0 to 2 percent slopes
- Rincon Clay Loam, 0 to 2 percent slopes
- Tidal Marsh
- Highway
- Paved road
- Closed to public
- Power line
- Railroad

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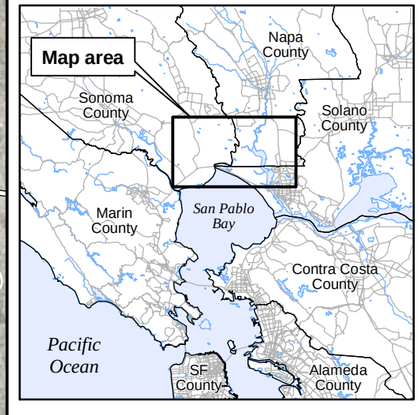
MILES

Base imagery:
Airphoto USA, 1 April 2007
0.3-meter cell size



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3.2.3 Clear Lake Series

The Clear Lake series consists of very deep, poorly drained soils that formed in fine textured alluvium derived from sandstone and shale or other mixed rock sources (NRCS 2004). Clear Lake soils are in basins and in swales of drainages. Slopes are 0 to 2%. The soils have negligible to high runoff and slow to very slow permeability.

3.2.4 Cortina Series

The Cortina series consists of very deep, somewhat excessively drained soils in small valleys and on alluvial fans and floodplains (NRCS 2004). These soils formed in gravelly alluvium from mixed rock sources. Slope ranges from 0 to 15%. They are excessively drained and have negligible to low runoff and rapid permeability.

3.2.5 Rincon Series

The Rincon series consists of deep, well drained soils that formed in alluvium from sedimentary rocks (NRCS 2004). Rincon soils are on old alluvial fans and both stream and marine terraces, and have slopes of 0 to 30%. These soils have slow to rapid runoff and slow permeability.

3.3 TOPOGRAPHY

Much of San Francisco Bay is shallow with an average depth of only 20 feet (USFWS 1998). Depth in San Pablo Bay averages less than 6 feet. Only 15% of the bay is more than 30 feet deep, though a few shipping channels are dredged deeper for ocean-going vessels.

Lands adjacent to the bay were historically tidal marshes interwoven with tidal sloughs, tidal ponds, and uplands. With the influx of Gold Rush fortune hunters and settlers, many of these marshes were drained and used for agriculture or filled for use in urban development. Over 90% of tidal marshes in the San Francisco Bay Estuary have been radically altered or lost due to hydraulic mining, farming, urbanization, salt production, and transportation systems. In the North Bay, 95% of San Pablo Bay tidal marshes have been levied or filled since 1860. The leveed areas include approximately 25,000 acres of seasonal and farmed wetlands. There are also 9,000 acres of former salt ponds.

The San Pablo Bay watershed comprises a series of parallel ridges and narrow valleys that run in a northwestern to southeastern direction (CDM 2000). The watershed's furthest upstream point to the north is Mount St. Helena. To the east, the boundary includes the Howell Mountains in Napa and Solano Counties, the Carquinez Strait and the Berkeley Hills in Contra Costa County. The western border includes a series of small mountain and hilltops including Loma Alta and Red Hill in Marin County, Meacham Hill and Sonoma Mountain in Sonoma County and the Mayacama Mountains in Napa and Sonoma Counties.

3.4 CLIMATE

The San Francisco Bay region has a Mediterranean-type climate, characterized by cool, wet winters and warm, dry summers. The San Pablo Bay and the Pacific Ocean dominate climatic conditions in the NSMWA. The mean annual temperature is 57°F, with a maximum mean of 67°F in September and a minimum mean of 41°F in December. Summer high temperatures rarely exceed 100°F and winter lows that fall below freezing are infrequent. Data collected between 1993 and 2001 indicate that rainfall in the project area averages 23 to 26 inches per year, with July rainfall averaging zero inches and January rainfall averaging between five and six inches.

Fog is a common occurrence in the summer. During periods of fog, visibility in the NSMWA may be reduced to a quarter mile or less. These periods occur from 60 to more than 80 days a year. The area is subject to consistent winds, typically from the southwest (i.e., entering through the Golden Gate), with highest wind speeds typically in the early afternoon, especially during the spring. Wind speeds average four to six miles per hour over the course of a year.

3.5 GLOBAL CLIMATE CHANGE AND IMPLICATIONS

While controversy continues about its magnitude and timing, scientists generally agree that global atmospheric concentration of carbon dioxide and world temperature are increasing and there are associated changes in sea level. During the last 100 years, globally average sea level has risen approximately 10 to 20 centimeters, or 1 to 2 millimeters per year (Scavia et al. 2002). Sea levels along California's coast have risen about 18 centimeters (CCCC 2006a) and Fort Point (San Francisco), the location of one of the longest continuously recording tide gauges in the world has recorded a 20-centimeter rise in the last century (Shellhammer 1989). Over the next 100 years, global warming is expected to accelerate the rate of sea level rise due to the expansion of oceanic water and to melting alpine glaciers and ice sheets. The full range of model projections, from the 2001 Intergovernmental Panel on Climate Change Assessment Report, spans from 9 to 88 centimeters rise in global sea level by 2100 (CCCC 2006b).

The potential impact of an accelerated rise in sea level in the San Francisco Bay was first described in a report to BCDC in 1985 (Shellhammer 1989). The report assumed a rise of 1.2 meters in the sea level of the Bay during the next 100 years. Thermal expansion, partial melting of glacial and polar ice, and tectonic sinking (land subsidence) were identified as attributing factors to the increase. A more extensive investigation commissioned by BCDC in 1987 assumed a lower average estimate of sea level rise but noted that tectonic sinking varies throughout the estuary, causing some areas to be influenced more strongly by sea level rise than others. The concept of relative mean sea level (RMSL) defines the difference between changes in sea level and either tectonic rising or sinking. The BCDC study projected an increase of 6 to 14 centimeters in RMSL in San Pablo Bay over the next 50 years. Model results from a study conducted by Galbraith et al (2002) predicted a sea level rise in northern San Francisco Bay of 30 centimeters by 2100.

Rising sea level is expected to inundate low-lying coastal areas, accelerate coastal erosion, threaten vital levees and inland water systems, and disrupt wetlands and natural habitat. Changes in the frequency of severe storms and increased rainfall intensity could further aggravate flooding and storm damage. Galbraith et al. (2002) projected a 39% loss of tidal flats at northern San Francisco Bay by 2100. This could have important implications for organisms that depend on these sites, especially rare and endangered plant and wildlife species.

Although dramatic changes to the NSMWA associated with sea level rise in the next decade (the time frame of this LMP) are unlikely, sea level rise may be a larger concern over the next century. In addition, some of the NSMWA wetlands are associated with uplands, allowing some wetland expansion and or providing refugial uplands as sea level rises.

3.6 HYDROLOGY AND WATER QUALITY

3.6.1 Hydrology

The hydrology of the NSMWA includes tidal and fluvial components comprising its estuarine condition. San Pablo Bay is one of three "subestuaries" in the San Francisco Bay-Delta, the largest estuary on the West Coast of North and South America (Jones and Stokes 2004a, 2004b). The tidal influence of San Pablo Bay is a major factor in the NSMWA's hydrological dynamics. (USACE 2004a). Twice daily, the waters of the Bay inundate the wetland to varying degrees, elevation dependent. The upstream extent of tidal inundation and estuarine mixing varies seasonally.

San Pablo Bay's drainage area of approximately 587 square miles includes four streams: Napa River, Sonoma, Tolay and Huichica creeks. Freshwater inputs to the NSMWA come in the form of direct precipitation and freshwater inflows from four streams (USACE 2004a; Wyckoff 2000) (**Figure 7)**. The Napa River, the largest and most important freshwater source to this system, flows for over 50 miles and drains a 426-square-mile watershed. Sonoma Creek, with a 143-square-mile watershed is the second largest watershed draining to San Pablo Bay. It flows for 26 miles from it's headwaters in northern Sonoma County. Two intermittent streams, Tolay Creek and Huichica Creek, provide smaller freshwater inputs to NSMWA. Tolay Creek drains an area of approximately 18 square miles into the western extremity of NSMWA. Huichica Creek is diverted in several locations into detention reservoirs for use in vineyards, reducing the volume of creek discharge to NSMWA.

3.6.1.1 Groundwater Resources

In the North Bay region, the principal groundwater-bearing aquifer is composed of alluvial deposits, which cover most of the Sonoma and Napa valleys. These aquifers are largely continuous, with general flow toward San Pablo Bay. In the region adjacent to the Bay, however, local flow has been reversed as a result of groundwater extraction, leading to saltwater intrusion.

Groundwater levels in the alluvial deposits vary locally, but are generally 5 to 75 feet below the ground surface.

The most significant natural recharge into alluvial aquifers occurs from rivers and streams. Generally, the alluvial deposits are not permeable enough to allow natural recharge from surface infiltration, although some limited recharge occurs through surface infiltration resulting from precipitation.

As the land elevation ascends into the Huichica mountain range, the groundwater aquifer changes because volcanic deposits are present. The Huichica formation is composed of reworked volcanic sediments that have a low specific groundwater yield. The low specific yield illustrates that this aquifer has lower productivity than alluvial deposits. The same soil conditions that limit productivity also limit recharge. The primary source of recharge is infiltration, usually through outcrops of the formation in the higher mountainous areas.

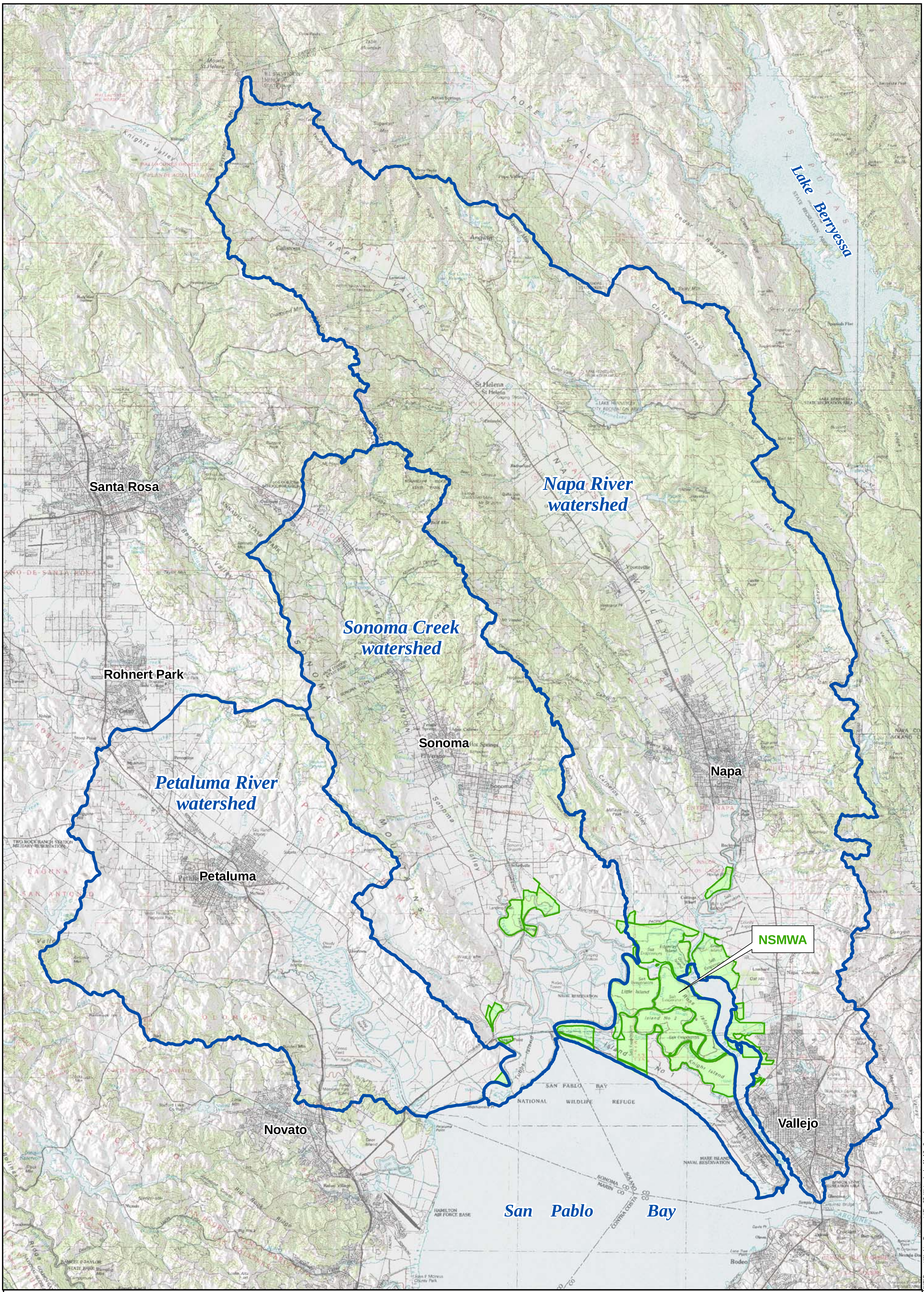
3.6.2 Water Quality

The hydrologic processes and fate and transport factors for chemical constituents in San Francisco Bay, its tributary rivers, and adjacent estuaries are complex and result in dynamic water quality conditions (URS 2006a). Water quality in the Bay-Delta estuary is largely a function of the mixing of ocean water and freshwater inflows from precipitation, the Delta, and other tributary streams. Water and sediment quality are affected by physical, chemical and biological processes including: heat, light and physical mixing of sediment, nutrients, and salts combined with primary and secondary biological productivity and by-products in the aquatic ecosystem. These ecosystem functions have secondary effects on dissolved oxygen, pH, and organic matter production and decay. In addition, the discharge of anthropogenic sources of conventional inorganic contaminants and trace metal and synthetic organic compounds also play a major role in the quality of bay water and sediments. Examples of anthropogenic sources include treated municipal and industrial point source discharges and non-point source discharges primarily generated by storm water runoff.

The USGS and SFEI Regional Monitoring Program (RMP) conduct extensive water quality monitoring activities in San Francisco Bay and its freshwater tributaries (URS 2006a). Water and sediment contamination from priority trace metal and synthetic organic compounds in the San Francisco Bay area largely reflects the influence of past and present agricultural and mining activities, industrial uses, and urban development. Contaminants known to be present in waters and sediments of the Bay-Delta estuary include heavy metals (lead, copper, aluminum, mercury, nickel, vanadium, chromium, silver, and zinc), PAHs, PCBs, chlorinated hydrocarbon pesticides, and tributyltin.

Within the North Bay region, constituents of concern that routinely exceed numeric guidance levels, human health guidelines, and/or regulatory concentration criteria include copper,

mercury, and PCBs (URS 2006a). Copper exceeds applicable criteria on an average basis in Napa River



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Napa Sonoma Marshes Wildlife Area (NSMWA)

Watershed boundary

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Napa Sonoma Marshes
Wildlife Area
Land Management Plan

FIGURE 7

Watersheds

and San Pablo Bay, however, individual measurements of mercury, nickel, chromium, lead, and zinc exceed criteria on one or more occasions (URS 2006a). PCBs and dichlorodiphenyldichloroethelene (DDE) were also measured above water quality guidelines at least once in the Napa River and San Pablo Bay. While the concentrations of PCBs have dropped since the 1970s, the RMP monitoring data have shown no clear trends in recent years.

Water quality and sediment monitoring is required pursuant to the RWQCB permit for the restoration of the Green Island Unit (Napa Plant Site) and the Napa River Unit (Ponds 1, 1A, 2, 3, 4, and 5) (Order No. R2-2004-0063; and subsequent amendment R2-2007-00475). Sediment and water quality monitoring at the two units by DFG staff includes measurements of salinity, ammonia and turbidity, temperature, pH, methyl mercury (in water and sediment), and dissolved oxygen. **Appendixes B** and **C** include a summary of the parameters monitored for each site.

3.6.2.1 Contaminant Sources

The sources and magnitude of contaminant loading to San Francisco Bay have been recently characterized as consisting primarily of the following categories: Central Valley via Delta inflows, local rivers, non-point source discharges, point-source discharges to the bay from municipal and industrial facilities, atmospheric deposition, and dredged material disposal (URS 2006a). Total suspended solids and contaminant influxes from the Delta comprise a large majority of the total loading in San Francisco Bay. Atmospheric deposition and dredged material disposal represent relatively small contributions. The relative magnitude of contaminant loading from local watershed sources and point-source discharges is constituent specific. For example, point-source discharges comprise the majority of inorganic nutrient (nitrogen [N] and phosphorus [P]) loading to San Francisco Bay, whereas trace metals inputs are primarily associated with local watershed sources. Relative source contributions of organic compounds have not been determined.

Trash at culvert outlet, White Slough Unit

3.6.2.2 Bittern and High Salinity Materials

High-salinity materials such as bittern, “pickle,” and other concentrated brine solutions are considered toxic waste by the RWQCB. Pond 7 in the Napa River Unit contains residual concentrated salts that remained after the harvest of sodium chloride (table salt). Bittern is not classified as a hazardous material but it is toxic to fish and other aquatic life due to its concentration and unbalanced salt mix. The bittern, pickle and other high salinity waters will need to be diluted and discharged in order to restore the former salt ponds such as Pond 7 and the Green Island Unit, southern section.

3.6.2.3 Pesticides, Fertilizers, and Non-point Source Discharges

The Napa River, Petaluma River, and Sonoma Creek watersheds were found to contribute a relatively high percentage of the total non-point source load of cadmium, chromium, copper, lead, nickel, and zinc to San Francisco Bay compared to other watersheds (SFEI 2000b). Pesticide and fertilizer used on agricultural lands may be discharged to the wetland and aquatic habitats of the NSMWA via small tributaries. Fuel spillage from agricultural sites and pump operation may have also caused local contamination. Streams and channels collect and carry non-point source pollutants and trash from near by neighborhoods, such as in the adjacent photo of a non-point source discharge to the White Slough Unit.

3.6.2.4 Mercury

The San Francisco Bay Mercury TMDL Project identified mercury sources as historic mines, urban runoff, wastewater discharges, atmospheric deposition, and re-suspension of contaminated sediments. Most of the historic mercury deposits date back to the Gold Rush of the late 1800's, when mercury was mined throughout the Coastal Range and used in the Sierra Nevada to extract gold. The single largest source is Delta outflow from Central Valley rivers.

The Biosentinel Mercury Monitoring Program (BMMP) included sampling sites within NSMWA. BMMP results from 2005-2006 of mercury in fish tissue samples from restored Napa River Unit ponds were generally lower than from upstream (Napa River at Napa) and San Pablo Bay samples (Slotton et al. 2006).

3.7 AGRICULTURAL RESOURCES AND LAND USES

This section describes the agricultural resource and existing land uses at the NSMWA and its surroundings.

The NSMWA is located in the North Bay region of the San Francisco Bay Area. The North Bay region is made up of Solano, Napa, Sonoma, and Marin counties, and includes the cities of American Canyon, Napa, Novato, San Rafael, Sonoma and Vallejo. The two predominant land uses in the North Bay are: extensive and intensive agriculture and rural land (60%), and wildlife and open space (23%). Remaining land uses: residential, commercial and light industry, public facilities, and heavy industry; each comprise less than 10% of the North Bay region (Jones and Stokes 2004a, 2004b). Three major land use trends are identified by BCDC (Jones and Stokes 2004a, 2004b): (1) transition of rangeland and pastureland in southern Napa and Sonoma counties to vineyards, (2) development of urban uses along the SR 101 and SR 29 corridors, and (3) acquisition of large rural areas by federal and state wildlife agencies for wildlife habitat.

Land uses adjacent to the NSMWA are generally as follows:

- East: mixed, ranging from general industrial to land intensive agriculture and residential uses. Immediately east of Pond 8, there is a strip of residential development.

- South: Mare Island has been designated by Solano County for mixed residential, commercial and industrial use, and wildlife habitat in the USFWS San Pablo Bay National Wildlife Refuge. Southwest of NSMWA, in Sonoma County, portions of Tubbs Island are considered farmland of local importance.
- West and northwest of the Napa River Unit across Napa Slough has been designated by Sonoma County as land extensive agriculture, consisting mainly of hay production (Jones and Stokes 2004a, 2004b). Vineyards are approximately 0.25 mile north of Pond 7A and east of the Green Island Unit. West of NSMWA, across Napa Slough, there are farmlands of local importance. The Infineon Raceway is located west of the North Tolay Creek Unit.
- North of NSMWA, in Napa County, there are lands designated as *prime farmland*, *land of local importance*, and *farmland of statewide importance*. The cities of Napa and Sonoma and the community of Schellville are to the north.

3.7.1 Grazing

As of 2008, cattle grazing only occurs in the Southern Crossing and Huichica Creek Units of the NSMWA (Huffman 2007a).

3.7.2 Farming

A mixture of oat, salt tolerant barley, vetch, bell beans and some native perennial bunchgrasses have been farmed on small strips throughout the Ringstrom Bay and Huichica Creek Units by DFG to enhance foraging and breeding habitat for upland game birds and waterfowl (Huffman 2007b).

3.8 BIOLOGICAL RESOURCES

3.8.1 Vegetation Types

A vegetation map of the NMSWA was completed in June of 2008. A detailed description of the methods, analysis and mapped vegetation types in the NSMWA is included in the *Napa & Sonoma Marshes Wildlife Area Vegetation Mapping Report* (AIS 2008). Vegetation units were classified using the latest hierarchy (June 2008) of the National Vegetation Classification Standard (NVCS). Vegetation was described at the alliance level (dominant or strong indicator overstory species presence) or at a multiple alliance level (superalliance). Vegetation classification was not based on plot data; instead vegetation classification types were drawn from identical or similar vegetation types described in previous mapping efforts in the vicinity of the NSMWA (AIS 2008). As of August 2008, the vegetation map was not formally assessed for accuracy. A formal assessment is recommended pending future funding in order to refine, update and improve the accuracy of this vegetation map. This is especially important for the NSMWA, since vegetation signatures, used to extrapolate vegetation classification across the landscape,

vary greatly due to the unique land use history, altered hydrology and complex intermixing of the different vegetation over small spatial scales in the NSMWA.

Thirty vegetation types are described for the NSMWA. Of the approximate 14,000 acres in the NSMWA, approximately 64% is open water. The vegetation type with greatest coverage in the NSMWA (1,085 acres) is the alkali bulrush type. Tidal marsh vegetation occurs on 2,865 acres of the NSMWA, representing nearly half of all the vegetation in the NSMWA (**Figure 8**). The following section summarizes vegetation types identified in the NSMWA. **Table 3-1** describes these vegetation types, and **Figure 8** depicts the vegetation within the NSMWA.

3.8.1.1 Forested Vegetation Types

Three forested vegetation types, covering approximately 20 acres, are described in the NSMWA, including: Fremont Cottonwood, Eucalyptus and Undifferentiated Exotic Trees. These vegetation types are described below.

Fremont Cottonwood

Fremont cottonwood vegetation is limited to a narrow, two acre strip along Huichica Creek in the Huichica Creek Unit. Dominant overstory plant species include Fremont cottonwood, willow (*Salix* spp.) and coast live oak (*Quercus agrifolia*). Understory plants include creeping wildrye (*Leymus triticoides*) and various non-native forbs and annual grasses.

Eucalyptus

Eucalyptus stands most often occur in rows or singly along the levees of the NSMWA. Eucalyptus (*Eucalyptus* spp.) is generally the only species in this vegetation type, with little to no understory vegetation. This vegetation type covers approximately 16 acres in the NSMWA.

Undifferentiated Exotic Trees

The undifferentiated exotic tree vegetation type in the NSMWA occurs along levees and in uplands of the NSMWA. This vegetation, covering 2 acres, has little to no understory vegetation. Dominant tree species include eucalyptus, black locust (*Robinia pseudoacacia*) and acacia (*Acacia* ssp.).

3.8.1.2 Scrub Vegetation Types

Scrub vegetation types in the NSMWA include French Broom, Coyotebrush-Gumplant, Mixed Willow and Tamarisk. Total acreage of scrub vegetation in the NSMWA is approximately 237 acres; the majority of which is the Coyotebrush-Gumplant vegetation type.

Napa Sonoma Marshes Wildlife Area Land Management Plan

FIGURE 8

Vegetation

Vegetation class (2008 vegetaion map)

Forest
- Eucalyptus (16 acres)
- Fremont Cottonwood Mapping Unit (2 acres)
- Undifferentiated exotic trees (2 acres)

Scrub
- Coyotebrush - gumplant (232 acres)
- French broom (< 1 acre)
- Mixed Willow Mapping Unit (4 acres)
- Tamarix (< 1 acre)

Herbaceous
- Annual grasses (155 acres)
- Annual pickleweed (19 acres)
- California cordgrass (87 acres)
- Creeping wildrye (1 acre)
- Iceplant (115 acres)
- Meadows and swales (spikerush, dock, rushes) (38 acres)
- Mixed cattail (158 acres)
- Mixed salt marsh (saltgrass, pickleweed, alkali heath) (515 acres)
- Mixed salt marsh (undifferentiated) (218 acres)
- Mixed Scirpus (1,042 acres)
- Mixed tule (6 acres)
- Mixed tule and cattail (696 acres)
- Non-native forbs (627 acres)
- Perennial pepperweed (140 acres)
- Pickleweed (555 acres)
- Ryegrass (21 acres)
- Saltgrass - alkali heath (247 acres)
- Teasel (< 1 acre)

Other
- Agriculture (37 acres)
- Built-up and urban disturbance (46 acres)
- Tidal flats and non-tidal salt pans (87 acres)
- Undefined areas with little or no vegetation (828 acres)
- Wetland restoration efforts (21 acres)

Water
- Water (9,059 acres)

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Table 3-1. Vegetation types in the NSMWA.

Vegetation Type	Acreage (approx)	Dominant Plant Species	Location in the NSMWA (Management Unit)
Forested			
Fremont Cottonwood Mapping Unit	2	Fremont cottonwood (*Populus fremontii*) and willow species (*Salix* spp.)	Huichica Creek Unit
Eucalyptus	16	*Eucalyptus* spp.	Southern Crossing Unit, Huichica Creek Unit, Southern Crossing Unit
Undifferentiated Exotic Trees	2	Black locust (*Robinia pseudoacacia*) and Eucalyptus (*Eucalyptus* sp.)	Huichica Creek Unit, Napa River Unit, Green Island Unit, Wingo Unit
Scrub			
French Broom	<1 acre	French broom (*Genista monspessulana*)	Huichica Creek Unit
Coyotebrush-Gumplant	233	Coyotebrush *(Baccharis pilularis)*, gumplant (*Grindelia* spp.)	All Management Units
Mixed Willow Mapping Unit	4	*Willow* spp. *(Salix lasiolepis*, *S. exigua*, *S. lucida* ssp. *Lasiandra)*	American Canyon, Tolay Creek Unit (north), White Slough Unit
Tamarisk	<1 acre	Tamarisk (*Tamarix* spp.)	Southern Crossing Unit
Herbaceous			
Meadows and Swales (spikerush, rushes and dock)	38	Spikerush (*Eleocharis* spp.), dock (*Rumex* spp.), rush (*Juncus* spp.)	Southern Crossing Unit, Tolay Creek (north) Unit, Ringstrom Bay Unit, American Canyon Unit, Green Island Unit, Huichica Creek, White Slough Unit
Creeping Wildrye	1	Creeping wildrye (*Leymus triticoides)*	Tolay Creek Unit (north)
Annual Grasses	155	Oatgrass *(Avena* spp.), brome (*Bromus* spp.), medusahead (*Taneatherum caput-medusea),* ryegrass (*Lolium* ssp.)	American Canyon Unit, Huichica Creek, Tolay Creek (north) Unit, Ringstrom Bay Unit, Sonoma Creek Unit, Southern Crossing Unit, White Slough Unit
Non-native Forbs	627	Mustard (*Brassica* spp.), radish (*Raphanus* spp.), poison hemlock (*Conium maculatum*), perennial pepperweed (*Lepidium latifolium),* annual grasses	All Management Units
Ryegrass	21	Ryegrass (*Lolium multiflorum, L. perenne*)	Ringstrom Bay, Tolay Creek (north) and Huichica Creek Units.
Teasel	<1 acre	Teasel (*Dipsacus sativus*)	Tolay Creek Unit (north)

Table 3-1. Vegetation types in the NSMWA.

Vegetation Type	Acreage (approx)	Dominant Plant Species	Location in the NSMWA (Management Unit)
Mixed Tule	6	Hardstem bulrush (*Schoenoplectus acutus*), California bulrush (*Schoenoplectus californicus*)	Coon Island Unit, Green Island Unit, Huichica Creek Unit, Napa River Unit, Ringstrom Bay Unit, Wingo Unit
Mixed Tule and Cattail	696	Hardstem bulrush (*Schoenoplectus acutus)*, California bulrush (*Schoenoplectus californicus*), cattails (*Typha latifolia*)	Southern Crossing Unit, Tolay Creek Unit, Ringstrom Bay Unit, American Canyon Unit, Napa River Unit, Wingo Unit, Green Island Unit, Huichica Creek, White Slough Unit, Coon Island Unit
Mixed Cattail	158	Broad-leaf cattail (*Typha latifolia*), narrow-leaf cattail (*Typha angustifolia*)	American Canyon Unit, Coon Island unit, Green Island Unit, Huichica Creek Unit, Tolay Creek (north) Unit, White Slough Unit, Ringstrom Bay Unit, Napa River Unit
Perennial Pepperweed	140	Perennial pepperweed (*Lepidium latifolium*)	American Canyon Unit, Coon Island Unit, Green Island unit, Huichica Creek Unit, Napa River Unit, Tolay Creek Unit, Ringstrom Bay Unit, Sonoma Creek Unit, White Slough Unit, Wingo Unit
Mixed Salt Marsh (saltgrass, pickleweed and alkali heath)	515	Saltgrass *(Distichlis spicata*), pickleweed (*Salicornia* spp.), alkali heath (*Frankenia salina*)	American Canyon Unit, Coon Island Unit, Green Island Unit, Huichica Creek Unit, Napa River Unit, Tolay Creek Unit, Ringstrom Bay Unit, Sonoma Creek Unit, Southern Crossing Unit, White Slough Unit
Mixed Salt Marsh (undifferentiated)	218	Saltgrass (*Distichlis spicata*), pickleweed (*Salicornia* spp.), alkali bulrush (*Scirpus maritimus*), Olneyi's bulrush (*Scirpus americanus*)	American Canyon Unit, Coon Island Unit, Green Island Unit, Huichica Creek Unit, Napa River Unit, Ringstrom Bay Unit, White Slough Unit
Saltgrass-Alkali Heath	247	Saltgrass (*Distichlis spicata*) and alkali heath *(Frankenia salina*)	American Canyon Unit, Coon Island Unit, Green Island Unit, Huichica Creek Unit, Napa River Unit, Tolay Creek Unit, Ringstrom Bay Unit, Sonoma Creek Unit, Southern Crossing Unit, White Slough Unit
Pickleweed	555	Pickleweed (*Salicornia* spp.)	American Canyon Unit, Coon Island Unit, Green Island Unit, Huichica Creek Unit, Napa River Unit, Tolay Creek Unit, Ringstrom Bay Unit, Sonoma Creek Unit, Southern Crossing Unit, White Slough Unit
Mixed Scirpus	1042	Alkali bulrush (*Scirpus maritimus*) Olney's bulrush (*Scirpus americanus*)	American Canyon Unit, Coon Island Unit, Huichica Creek Unit, Napa River Unit, Tolay Creek Unit, Ringstrom Bay Unit, Sonoma Creek Unit, Southern

Table 3-1. Vegetation types in the NSMWA.

Vegetation Type	Acreage (approx)	Dominant Plant Species	Location in the NSMWA (Management Unit)
			Crossing Unit, White Slough Unit, Wingo Unit
California Cordgrass	87	California cordgrass (*Spartina foliosa*)	American Canyon Unit, Coon Island Unit, Green Island Unit, Huichica Creek Unit, Napa River Unit, Rigstrom Bay Unit, Sonoma Creek Unit, Tolay Creek Unit, White Slough Unit
Annual Pickleweed	19	Annual pickleweed (*Salicornia* spp.)	Sonoma Creek Unit
Iceplant	115	Iceplant (*Carpobrotus edulis*, *Mesembryantherum* spp.)	Huichica Creek Unit (Pond 8), Napa River Unit, Green Island Unit, Sonoma Creek Unit
Other			
Agriculture	37	None	American Canyon Unit, Green Island Unit, Huichica Creek Unit, Tolay Creek Unit, Ringstrom Bay Unit
Built-up and Urban Disturbance	46	None	American Canyon Unit, Coon Island Unit, Green Island Unit, Huichica Creek Unit, Napa River Unit, Ringstrom Bay Unit, Sonoma Creek Unit, White Slough Unit, Wingo Unit
Tidal Flats and Non-tidal Salt Pans	87	None	Coon Island Unit, Huichica Creek Unit, Napa River Unit, Tolay Creek Unit, Ringstrom Bay Unit, Sonoma Creek Unit, Southern Crossing Unit, White Slough unit
Undefined Areas with Little or No Vegetation	828	None	Green Island Unit, Huichica Creek Unit, Napa River Unit, Tolay Creek Unit, Ringstrom Bay Unit, Southern Crossing Unit, White Slough Unit
Wetland Restoration Efforts	22	None defined	Ringstrom Bay, Huichica Creek Unit, White Slough Unit

French Broom

The French Broom vegetation type was mapped at only one location on the southern levee of Pond 8 in the NSMWA. The dominant plant species at this location is French broom (*Genista monspessulana*), with a small component of coyotebrush (*Baccharis pilularis*). It covers less than one acre.

Coyotebrush-Gumplant

The Coyotebrush-Gumplant vegetation type, covering 233 acres, is widespread along levees of the NSMWA. Dominant species include coyotebrush and gumplant (*Grindelia* spp.). This vegetation type often interfaces with non-native annual grasses and forbs with gumplant dominating at lower positions on levees adjacent to tidal wetlands.

Mixed Willow

The Mixed Willow vegetation type occurs in the American Canyon and White Slough Units of the NSMWA. Dominant overstory species include various willow species including arroyo willow (*Salix lasiolepis*), yellow willow (*Salix lucida* ssp. *lasiandra*) and sandbar willow (*Salix exigua*). Understory vegetation include sapling Fremont cottonwood and both native and non-native annual grasses and forbs. This vegetation type covers approximately 4 acres in the NSMWA.

Tamarisk

The Tamarisk vegetation type was mapped at one location in a tidal marsh in the Southern Crossing Unit. The tidal marsh is located along the outboard side of the levee that parallels the Napa River. This vegetation type covers less than one acre, and is dominated by tamarisk (*Tamarix* spp.).

3.8.1.3 Herbaceous Vegetation

Herbaceous vegetation, covering approximately 4,639 acres, is the dominant vegetation in the NSMWA. Herbaceous vegetation types include Meadows and Swales, Creeping Wildrye, Annual Grasses, Non-native Forbs, Ryegrass, Teasel, Mixed Tule, Mixed Tule-Cattail, Mixed Cattail, Perennial Pepperweed, Mixed Salt Marsh (saltgrass, pickleweed, and alkali heath), Mixed Salt Marsh (undifferentiated), Saltgrass-Alkali heath, Pickleweed, Mixed Scirpus, California Cordgrass, Annual Pickleweed and Iceplant.

Meadows and Swales

Meadows and Swales cover approximately 38 acres in the NSMWA, primarily occurring at the Ringstrom Bay, Southern Crossing, Huichica Creek, Tolay Creek (north) and the American Canyon Units. Meadows and Swales are found in temporarily to seasonally flooded settings away from tidal influence. They are often found adjacent to upland grasses in depressions or in drainages where water collects. Spikerush (*Eleocharis* sp.) and/or rush (*Juncus* sp.) dominate;

often with a component of mesic grasses and forbs. Saltgrass (*Disticlis spicata*) may be a minor component to meadows with saline soils. Upland annuals may be a component to drier stands.

Creeping Wildrye

The Creeping Wildrye vegetation type occurs on one acre in the Tolay Creek (north) in the NSMWA. Creeping wildrye is the dominant species, but can co-occur with rushes and giant wildrye (*Leymus condensatus*). This vegetation type in the NSMWA occurs in a seasonally flooded landscape in an area that was once within the floodplain of Tolay Creek.

Annual Grasses

The Annual Grasses vegetation type is composed of annual grasses, often with a component of annual forbs and introduced perennial grasses. Within the NSMWA, this vegetation type covers 155 acres. Fairly extensive stands are mapped in upland settings, especially along the northern fringes of the Huichica Creek and Tolay Creek Unit (north). Small patches of native creeping wildrye or non-native perennials grasses such as Harding grass may occur in these polygons.

Non-native Forbs

This vegetation type is similar to Annual Grasses vegetation type; however forbs are the dominant species. Examples include stands dominated with any number of non-native species such as mustard, radish and poison hemlock; annual grasses also are a significant component to the stand. The Non-native Forbs vegetation type is mapped primarily along levees and along marginally tidal zones (where perennial pepperweed may dominate), covering approximately 627 acres.

Ryegrass

The Ryegrass vegetation type is dominated by the non-native ryegrass (*Lolium* spp.), occurring with other non-native annual grasses and forbs. It is limited to a few areas, covering 21 acres, in the Ringstrom Bay, Tolay Creek (north) and Huichica Creek Units.

Teasel

The Teasel vegetation type is mapped in only one small location (< 1 acre) in the Tolay Creek (north). This vegetation type is dominated by teasel (*Dipsacus sativus*).

Mixed Tule

The Mixed Tule vegetation type, covering 6 acres, occurs where hardstem bulrush or California bulrush strongly dominates or co-dominates. Other freshwater or brackish water vegetation species may be a minor component of this vegetation type. Mixed Tule occurs primarily in fresh or brackish water environments along the margins of former salt ponds, especially along the larger sloughs.

Mixed Tule-Cattail

This vegetation type occurs where bulrushes dominate, co-dominate or are subordinate to broad-leaf cattail (*Typha latifolia*). Narrowleaf cattail (*T. angustifolia*) can also occur in the stand. Most freshwater or brackish marshes are mapped to this vegetation type, and occur on nearly all of the management units. The most extensive stands were mapped on the northern portions of the Coon Island Unit and along the edges of many of the larger sloughs throughout the NSMWA. This vegetation type covers 696 acres in the NSMWA.

Mixed Cattail

Mixed Cattail vegetation type, covering 158 acres in the NSMWA, is dominated by broad-leaf cattail, and is generally found in fresh or brackish water settings. In more saline water, narrow-leaf cattail often replaces broad-leaf cattail as a dominant. The most extensive stands of this vegetation type occur at Pond 2A of the Napa River Unit.

Perennial Pepperweed

This vegetation type, covering approximately 150 acres in the NSMWA, is dominated by perennial pepperweed, and occurs in upland and partial to fully tidal settings. It frequently occurs on levees lining smaller sloughs at slightly higher elevations then the adjacent tidal wetlands. Extensive stands of this vegetation type occur at the Ringstrom Bay Unit.

Mixed Salt Marsh (saltgrass, pickleweed, and alkali heath)

This vegetation type describes areas where pickleweed and saltgrass form complex patterns, often with a minor component of alkali health and jaumea (*Jamea carnosa*). Vegetative cover varies considerably, especially where stands are adjacent to salt pans. Many stands have a component of perennial pepperweed when adjacent to tidal sloughs. Mixed Salt Marsh is found in hyper-saline environments in a range of tidally flooded regimes and adjacent to salt pans. This vegetation type covers approximately 515 acres in the NSMWA.

Mixed Salt Marsh (undifferentiated)

The Mixed Salt Marsh vegetation type, covering 218 acres in the NSMWA, consists of a complex of three or more species. Complexing happens when individual species dominance occurs in patches too small to delineate or in areas where species mix evenly within the stand. Most areas where it occurs contain components of alkali bulrush, saltgrass, and pickleweed. Mixed Salt Marsh occurs in similar physical setting to the Mixed Salt Marsh (saltgrass, pickleweed, and alkali heath), but flooding regimes within the mapped areas vary considerably due to the presence of both alkali bulrush and pickleweed.

Saltgrass-Alkali Heath

Saltgrass-Alkali Heath vegetation type is defined in those areas where saltgrass and alkali heath occur together, however saltgrass most often is the dominant. This type occurs over 247 acres, in higher elevations, in upper tidal areas or areas above all tidal influence in saline soils. It is

common on the northern properties and also on the Tolay Creek Unit (north) and American Canyon Unit. Saltgrass-Alkali Heath often border Annual Grasses and Non-native Forbs vegetation types; in these area the Saltgrass-Alkali Heath may contain a component of annual grasses or forbs.

Pickleweed

The Pickleweed vegetation type, covering 55 acres in the NSMWA, is dominated by pickleweed. Other species, especially saltgrass, may be a minor component of this type. It generally occurs in more regularly flooded tidal areas than the Saltgrass-Alkali Heath vegetation type; but it is also common in non-tidal salt pans in hyper saline conditions.

Mixed Scirpus

The Mixed Scirpus vegetation type, covering 1,042 acres, occurs primarily where alkali bulrush is the dominant species. In some areas of the NSMWA, three square (*Schoenoplectus pungens*) may be the dominant species. Understory herbaceous vegetation may contain a significant component of pickleweed. This vegetation type is located in areas with more frequent flooding than Pickleweed and Saltgrass-Alkali Heath vegetation types. It is often noted surrounded by Mixed Tule vegetation, where other species of bulrush or cattail may surround the polygon closer to the fringes of former salt ponds. It is rarely noted along the margins of larger sloughs.

California Cordgrass

This vegetation type, covering approximately 87 acres, is dominated by California cordgrass. Scirpus (*Scirpus* spp.) may be in close proximity or complexing within the areas mapped as this vegetation type. Cover varies considerably and overall patterning within the California Cordgrass vegetation type ranges from continuous to patchy. It occurs most frequently along the outer fringes of tidal marshes, except in interior former salt ponds (such as Pond 2A) adjacent to water.

Annual Pickleweed

This vegetation type is composed almost exclusively of annual pickleweed. Vegetative cover of annual pickleweed ranges from sparse (adjacent and within tidal flats) to dense settings (tidal marsh). Pickleweed (perennial) can be a minor component to the stand. This vegetation type covers 19 acres only within the Sonoma Creek Unit, adjacent to tidal mudflats where annual pickleweed is a sparse component and increasing in density to where it often grades into pickleweed (perennial).

Iceplant

The Iceplant vegetation type is composed of any one of several species of iceplant as a dominant, with annual non-forbs and annual grasses. It occurs exclusively on levees in the NSMWA; especially in Huichica Creek Unit (Pond 8) and on levees of the Napa River Unit. This vegetation type covers 115 acres in the NSMWA.

3.8.1.4 Other

Other vegetation types in the NSMWA describe those areas with little to no vegetation, including areas with buildings and other structures, as well as areas used for agriculture (vineyards and dry-land farming). Other vegetation types also include wetland restoration sites with no vegetation, as well as barren areas and mudflats. Total acreage of these vegetation types in the NSMWA is approximately 1021 acres.

Agriculture

Most examples of this type are vineyards, as well as small areas along the edges of management units that are dry-land farmed. It occurs in the Ringstrom Bay, Huichica Creek, Green Island and Southern Crossing Units of the NSMWA. Total cover of Agriculture in the NSMWA is 37 acres.

Tidal Flats and Non-tidal Salt Pans

Tidal Flats and Non-tidal Salt Pans vegetation type describes areas where vegetative cover is generally below 5%; often containing a small component of pickleweed along the fringes. This vegetation type is scattered throughout the NSMWA. This vegetation type covers 87 acres in the NSMWA.

Built-up and Urban Disturbance

Built-up and Urban Disturbance, covering 46 acres, describes areas covered in man made structures. These are relatively small areas in the NSMWA; the largest example is located on the northern portion of the Green Island Unit, north of the salt evaporators.

Undefined Areas with Little or No Vegetation

This vegetation type includes unvegetated, non-urban areas in the NSMWA. The majority of this type is mapped in the Wingo Unit, and along levees and scattered throughout the NSMWA. This vegetation type covers 828 acres in the NSMWA.

Wetland Restoration Efforts

While some restoration sites in the NSMWA are classified to a specific vegetation type, this type lacked established vegetation at the time of classification (2008). It is mapped in the Ringstrom Bay, Huichica Creek and White Slough Units of the NSMWA. This vegetation type covers 22 acres in the NSMWA.

3.8.1.5 Non-Native Plants

Non-native plants occur throughout the NSMWA (**Table 3-2**). Many non-native plants were introduced to North America after European arrival, accidentally and purposefully for agriculture, grazing landscaping and other uses. Many of these introduced, non-native plants disrupt California ecosystems in which they are introduced, displacing native plants and wildlife, and in some cases, changing ecosystem processes such as hydrology, fire regime, and soil

chemistry (Cal-IPC 2008). Non-native plants observed in the NSMWA that pose the greatest threat to the integrity of the biota of the NSMWA include Pacific bentgrass (*Agrostis avenacea*), lance-leaf water plantain (*Alisma lanceolata*), giant reed (*Arundo donax*), yellow star thistle (*Centaurea solstisialis*), Scotch and French broom (*Cytisus scoparius and Genista monspessulana)*, perennial pepperweed (*Lepidium latifolium*), common reed (*Phragmites australis*), tamarisk (*Tamarix* sp.), medusahead (*Taneatherum caput-medusea*), and Himalayan blackberry (*Rubus discolor*). As of 2008, there are no maps of the location or extent of these species or other non-native plants in the NSMWA.

In addition to non-native species observed in the NSMWA, non-native cordgrass (*Spartina* sp.) was observed in the immediate vicinity of the NSMWA. High priority non-native species (including non-native cordgrass) are discussed in detail below.

Table 3-2. Non-native plants of the NSMWA.

Scientific Name	Common Name	Cal-IPC Rating[1]
Polypogon monspeliensis	Annual beard grass	Limited
Asparagus officinalis ssp. *officinalis*	Asparagus	None
Atriplex semibaccata	Australian saltbush	Moderate
Cynodon dactylon	Bermuda grass	Moderate
Convolvulus arvensis	Bindweed	Eval. not listed
Lotus corniculatus	Birdfoot trefoil	Eval. not listed
Brassica nigra	Black mustard	Moderate
Acacia melanoxylon	Blackwood acacia	Limited
Eucalyptus globulus	Blue gum	Moderate
Cotula coronopifolia	Brass-buttons	Limited
Picris echioides	Bristly ox-tongue	Limited
Malva nicaensis	Bull mallow	No rating
Cirsium vulgare	Bull thistle	Moderate
Anthriscus caucalis	Bur-chervil	None
Medicago polymorpha	California burclover	Limited
Daucus carota	Carrot	Eval. not listed
Apium graveolens	Celery	None
Malva parviflora	Cheeseweed	No rating
Cichorium intybus	Chicory	No rating
Xanthium strumarium	Cocklebur	No rating
Phragmites australis	Common reed	No listing
Sonchus oleraceus	Common sow thistle	No rating
Avena sativa	Cultivated oat	None
Rumex crispus	Curly dock	Limited
Ruppia maritima	Ditch-grass	No rating
Plantago lanceolata	English plantain	Limited
Hordeum murinum	Farmer's foxtail	No rating

Table 3-2. Non-native plants of the NSMWA.

Scientific Name	Common Name	Cal-IPC Rating[1]
Rumex pulcher	fiddle dock	No rating
Carpobrotus edulis	Fig marigold	High
Erodium botrys	Filaree	Eval. not listed
Genista monspessulana	French broom	High
Dipsacus sativus	Fuller's teasel	Moderate
Geranium dissectum	Geranium	Moderate
Arundo donax	Giant reed	High
Acacia decurrens	Green wattle	None
Spergularia villosa	Hairy sandspurry	No rating
Phalaris aquatica	Harding grass	Moderate
Rubus discolor	Himalayan blackberry	High
Lythrum hyssopifolium	Hyssop loosestrife	Moderate
Lolium multiflorum	Italian ryegrass	Moderate
Carduus pycnocephalus	Italian thistle	Moderate
Sorghum halepense	Johnsongrass	No rating
Chenopodium album	Lamb's quarters	No rating
Alisma lanceolatum	Lance-leaf water plantain	None
Robina pseudoacacia	Locust	Limited
Hordeum marinum ssp. *gussoneanum*	Mediterranean barley	Moderate
Taeniatherum caput-medusae	Medusahead	High
Silybum marianum	Milk thistle	Limited
Tetragonia tetragonioides	New Zealand spinach	No rating
Solanum americanum	Nightshade	No rating
Agrostis avenacea	Pacific bentgrass	Limited
Cortaderia selloana	Pampas grass	High
Lepidium latifolium	Perennial pepperweed	High
Lolium perenne	Perennial ryegrass	No rating
Schinus molle	Peruvian pepper tree	Limited
Amaranthus sp.	Pigweed	None
Chenopodium macrospermum var. *halophilum*	Pigweed	No rating
Conium maculatum	Poison hemlock	Moderate
Ranunculus muricatus	Prickle-fruited buttercup	No rating
Lactuca serriola	Prickly lettuce	Eval not listed
Sonchus asper	Prickly sow thistle	Eval. not listed
Polygonum arenastrum	Prostrate knotweed	No rating
Raphanus sativus	Radish	Limited
Spergularia rubra	Red sandspurry	No rating
Bromus diandrus	Ripgut grass	Moderate
Hypochaeris radicata	Rough cat's-ear	Limited

Table 3-2. Non-native plants of the NSMWA.

Scientific Name	Common Name	Cal-IPC Rating[1]
Tragopogon porrifolius	Salsify	No rating
Spergularia media	Sandspurrey	No rating
Cytisus scoparius	Scotch broom	High
Carpobrotus chilensis	Sea fig	Moderate
Rumex acetosella	Sheep sorrel	Moderate
Avena barbata	Slender wild oat	Moderate
Mesembryanthemum nodiflorum	Slender-leaved iceplant	No listing
Bromus hordeaceus	Soft chess	Limited
Meliotus indica	Sourclover	No rating
Crypsis schoenoides	Swamp timothy	No rating
Lobularia maritima	Sweet alyssum	Limited
Festuca arundinacea	Tall fescue	Moderate
Tamarix sp.	Tamarisk	High
Scandix pecten-veneris	Venus' needle	No rating
Echinochloa crus-galli	Watergrass	No rating
Meliotus alba	White sweetclover	No rating
Avena fatua	Wild oat	Moderate
Brassica rapa	Wild turnip	Limited
Sisymbrium orentale	Yellow mustard	No rating
Centaurea solstitialis	Yellow star-thistle	High

[1]California Invasive Plant Council (Cal-IPC) Weed Ratings:

High: These species have severe ecological impacts on ecosystems, plant and animal communities, and vegetational structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. These species are usually widely distributed ecologically, both among and within ecosystems.

Medium: These species have substantial and apparent - but generally not severe - ecological impacts on ecosystems, plant and animal communities, and vegetational structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.

Low: The ecological impacts of these species are minor. Their reproductive biology and other invasiveness attributes result in low to moderate rates of invasion. Ecological amplitude and distribution are generally limited (these species may be locally persistent and problematic).

Alert: This is an additional designation for some species in either the high or medium category whose current ecological amplitude and distribution are limited. The designation alerts managers to species that are capable of rapidly invading unexploited ecosystems, based on initial, localized observations, and on observed ecological behavior in similar ecosystems elsewhere.

Evaluation Not Listed: In general, this designation is for species for which information is currently inadequate to respond with certainty to the minimum number of criteria questions (i.e., too many "U" responses), or for which the sum effects of ecological impacts, invasiveness, and ecological amplitude and distribution fall below the threshold for ranking (i.e., the overall rank falls below Low). Many such species are widespread but are not known to have substantial ecological impacts (though such evidence may appear in the future). All species receiving a "D" score for ecological impact, regardless of what other section scores they receive, are by default placed into this category.

Pacific Bentgrass

Pacific bentgrass is a perennial grass in the grass family (Poaceae) from Australia that is a recent invader of the San Francisco Bay. In the NSMWA, it occurs in the mesic grasslands of the Huichica Creek Unit. This species reproduces by seed and occurs throughout the Napa-Sonoma Marshes, including Cullinan Ranch (Baye 2008). This species is broadly tolerant of different hydroperiods and spreads widely through 'tumbleweed' dispersal, often clogging drainage ditches in the Napa-Sonoma Marshes (Zedler and Kercher 2004).

Lance-leaf Water Plantain

Lance-leaf water plantain is a robust, emergent aquatic plant in the water plantain family (Alismataceae). This plant very closely resembles the native water plantain (*Alisma plantago-aquatica*); however, lance-leaf plantain differs from the native plantain morphologically, having lanceolate-shaped leaves and pink flowers. Lance-leaf water plantain grows vigorously in ditches, canals and wetlands in the NSMWA. A large, dense infestation of this species occurs in ditches and diked baylands of the Tolay Creek Unit (north). This species likely reproduces from underground root structures, as well as through water and wildlife dispersal of seeds. This species appears to be expanding its range in tidal and diked baylands of the Napa-Sonoma and Petaluma marshes (Baye 2008). Extensive suitable habitat occurs throughout the NSMWA.

Giant Reed

Giant reed, also known as arundo, is a large, robust perennial grass (Poaceae) that grows up to 30 feet tall. It primarily spreads via underground tubers, occurring most often in areas with ample fresh or brackish water along riparian areas, floodplains, estuaries and drainage ditches. Large infestations of giant reed can result in alteration of hydrology, vegetation structure and function, fire frequency and loss of wildlife habitat. Giant reed occurs in a few small clumps along Napa Slough, American Canyon Unit, Tolay Creek Unit and along Catalina Circle in the White Slough Unit.

Iceplant

Iceplant (*Carpobrotus* spp.) is a succulent plant in the fig-marigold family (Azioaceae). Several species of iceplant occur in the NSMWA, almost exclusively on levees surrounding former salt ponds, most notably at the Green Island and Huichica Creek Units. Iceplant forms thick, low growing mats with stems that root at aboveground nodes. This plant is found close to the coast in dunes, coastal scrub, coastal prairie and disturbed areas. It reproduces vegetatively as well as by seed. Iceplant is a strong competitor with native plants, and provides little structural diversity for wildlife.

Yellow Star Thistle

Yellow star thistle is a winter annual forb in the aster family (Asteraceae). Yellow star thistle propagates rapidly by seed; a large plant can produce nearly 75,000 seeds (Cal-IPC 2008). Yellow star thistle grows primarily in grasslands and woodlands of California. Yellow star thistle

is known to deplete soil moisture, reduce wildlife forage and habitat, displace native plants, and decrease native plant and wildlife diversity (Cal-IPC 2008).

In the NSMWA, yellow star thistle potentially grows in the upland grasslands and levees of the NSMWA including the Ringstrom Bay Unit, Tolay Creek Unit (north of SR 37), American Canyon Unit, and the Huichica Creek Unit.

Slender Iceplant

Slender leaved iceplant is a perennial succulent in the fig-marigold family. This plant grows in spreading clumps on the edges of former salt ponds in saline soils. Elsewhere in California it grows in alkaline flats in the San Joaquin Valley, where it can invade and become the dominant plant species (Cooley 2008). This species is poorly documented in California, and the ecology is not well understood.

Scotch and French Broom

Scotch and French broom are perennial shrubs in the pea family (Fabaceae) that invade and thrive in sunny, disturbed areas of California. They are strong competitors for sunlight and nutrients. Along the coast of California, Scotch broom flowers and produces seed from May through June, and young plants take two to three years to produce seed. The most rapid growth occurs in May. French broom in coastal California flowers from March through July, and seeds mature in June-July on plants that are two to three years of age.

Scotch and French broom are limited in the NSMWA, only known to occur on a levee along Pond 8 of the Huichica Creek Unit.

Perennial Pepperweed

Perennial pepperweed is a perennial forb in the mustard family (Brassicaceae). It grows vigorously in moist or seasonally wet sites, forming dense colonies that exclude native species. It reproduces by seed and vegetatively by an extensive root system (Cal-IPC 2008). Populations expand clonally at rates of several yards per year in seasonal wetlands (Rentz and Blank 2004). It appears to grow lower in the intertidal zone in fresher parts of the San Francisco estuary and higher in more saline areas, though in saline areas it is still associated with freshwater flows

Perennial pepperweed stand at Tolay Creek Unit

(SFEI 1998). Perennial pepperweed may alter soil salinity, acting as a "salt pump" as it removes salts from deep in the soil profile and leaves salt deposits on soil surface. Old stems of this plant take several years to degrade and can form a layer impenetrable to light (Cal-IPC 2008).

In the Napa-Sonoma Marshes, perennial pepperweed is abundant in the tidal marshes associated with Tolay Creek, Huichica Creek, Fagan Marsh and Bull Island Ecological Reserves, Mare Island, as well as along most levees and in the seasonal wetlands of former salt ponds.

Common Reed

Common reed is a large perennial grass in the grass family. It is a clonal species that reproduces both vegetatively through rhizomes and by seed dispersal. It is typically found in wetlands, ditches and canals. There is some controversy associated with the taxonomy and potential impacts to ecosystems from common reed in North America (EPA 2002). Further studies are needed in order to determine what management actions, if any, are necessary for common reed in the NSMWA.

Tamarisk

Tamarisk, or saltcedar, is a perennial shrub in the salt cedar family (Tamaricaceae). There are several species of salt cedar that occur in California, all of which are non-native. Tamarisk grows in abundance where the surface or subsurface water is abundant, and can thrive in saline soils. It spreads by both by seed and vegetatively. One dense grove of tamarisk shrubs occurs on the eastern levee of the Southern Crossing Unit of the NSMWA along the Napa River.

Medusahead

Medusahead is an annual grass (Poaceae) that is widespread in grasslands and oak woodlands of California. Medusahead reproduces by seed, and is dispersed by wind, water, wildlife and livestock. It is a very strong competitor with native plants, often prohibiting the growth of other species through the dense litter produced after plant senescence. The high silica content of the plant makes it unpalatable to livestock and wildlife except early in the growing season. This species occurs in grasslands of the NSMWA, most notably in the uplands of the Tolay Creek Unit (north).

Cordgrass

Several non-native cordgrass species (Poaceae) occur in the San Francisco Bay, including *S. angelica*, *S. alterniflora*, *S. densiflora* and *S. patens*. The native California cordgrass (*Spartina foliosa*), occurs throughout the sloughs and fringes of former salt ponds of the NSMWA. A single *S. densiflora* plant was found in Pond 2A in 2001. The plant was removed and follow-up monitoring has shown no recurrence. It was also found in White Slough on property owned by the California Department of Transportation (Wyckoff 2008). The non-native cordgrass spreads rapidly both vegetatively and by seed, hybridizing with the native species; if left unchecked infestations can alter tidal marsh structure and function.

Himalayan Blackberry

Himalayan blackberry is a sprawling viney shrub composed of thick canes with sharply hooked thorns. This member of the rose family (Rosaceae) prefers wet or moist disturbed areas. Himalayan blackberry reproduces by seed, which spread readily by birds and other wildlife, attracted to its fruit, as well as by streams and rivers. It also spreads rapidly vegetatively by rooting canes, and quickly displaces native plant species (Cal-IPC 2008). This species has a high potential to occur along the riparian corridors and upland grasslands of the NSMWA.

3.8.2 Wildlife and Habitats

The following section discusses NSMWA wildlife habitat types, including wetlands (seasonal wetlands, tidal marsh, perennial wetlands and mudflats), uplands (grasslands, levees, stands of non-native trees), riparian habitat, other habitat types (open water including rivers, sloughs and bays and managed former salt ponds). A brief description of wildlife habitat types and the associated wildlife are discussed below, followed by a more detailed description of these habitat types in each Management Unit of the NSMWA. Wildlife habitats correspond to vegetation types described in **Section 3.8.1**. A crosswalk between NSMWA vegetation types (NVCS) and NSMWA wildlife habitats is provided in **Table 3-3**.

3.8.2.1 Wildlife Habitat Descriptions

Wetland Habitats

Wetland habitats in the NSMWA vary greatly by salinity, soil type, topography and vegetation, dramatically altering the wildlife communities that utilize them. Wetlands provide habitat to some of the most complex and dynamic communities of invertebrates, which in turn act as prey to a variety of larger vertebrates.

The seasonal wetlands, mudflats, tidal marshes, levees, and open water of the NSMWA provide important wintering grounds for thousands of waterfowl and shorebirds that migrate through California every year, acting as a key stopover along the Pacific Flyway (**Figure 9**). The waterfowl population in the NSMWA dramatically increases from November to March during winter migration, decreasing in the warmer months from April to October (CDFG 1977). Waterfowl in the NSMWA includes both diving and dabbling ducks. A diverse group of shorebirds and wading birds migrate through, reside, winter and/or breed in the NSMWA. These birds utilize seasonal wetlands, upland grassland, levees, tidal wetlands, channels, shallow open water and mudflats of the NSMWA. In addition to waterfowl and shorebirds, a variety of other water-associated birds breed and/or visit the NSMWA. Flocks of American white pelicans (*Pelecanus erythrorhynchos*) and gulls (*Larus* sp.) visit the Marshes in the winter. Double-crested cormorants (*Phalacrocorax auritus*) and Caspian terns (*Sterna caspia*) have been known to nest in the NSMWA. Flamingo sightings occur on occasion in the NSMWA.

Table 3-3. Crosswalk between NSMWA vegetation types and NSMWA wildlife habitats.

National Vegetation Classification System Vegetation Type	NSMWA Wildlife Habitat
Fremont Cottonwood Mapping Unit	Riparian
Eucalyptus	Non-native trees, levee
Undifferentiated Exotic Trees	Non-native trees
French Broom	Levee
Coyotebrush and Gumplant	Levee
Mixed Willow Mapping Unit	Riparian, levee
Tamarisk	Levee
Meadows and Swales (spikerush, rushes and dock)	Grassland, seasonal wetland
Creeping Wildrye	Grassland, seasonal wetland
Annual grasses	Grassland
Non-native forbs	Grassland, seasonal wetland
Ryegrass	Grassland, seasonal wetland
Teasel	Grassland
Mixed Tule	Tidal marsh, perennial wetland
Mixed Tule and Cattail	Tidal marsh, perennial wetland
Mixed Cattail	Tidal marsh, perennial wetland
Perennial Pepperweed	Tidal marsh, levees, seasonal wetland, grassland
Mixed Salt Marsh (saltgrass, pickleweed, and alkali heath)	Perennial wetland, seasonal wetland
Mixed Salt Marsh (undifferentiated)	Tidal marsh
Saltgrass and Alkali Heath	Tidal marsh, seasonal wetland
Pickleweed	Tidal marsh, seasonal wetland
Mixed Scirpus	Tidal marsh
California Cordgrass	Tidal marsh
Annual Pickleweed	Tidal marsh
Iceplant	Levees
Agriculture	Grassland
Built-up and Urban Disturbance	None
Tidal Flats and Non-tidal Salt Pans	Managed former salt ponds, mudflats, open water; rivers sloughs and bays
Undefined Areas with Little or No Vegetation	Managed former salt pond, seasonal wetland
Wetland Restoration Efforts	Managed former salt ponds, seasonal wetland

Figure 9. Pacific Flyway Route.

White tailed kites (*Elanus leucurus*), northern harriers (*Circus cyaneus*), peregrine falcons (*Falco peregrinus*), golden eagles (*Aquila chrysaetos*) and turkey vultures (*Cathartes aura*) hunt throughout the NSMWA for most of the year. Ferruginous hawk (*Buteo regalis*) and Swainson's hawk (*Buteo swainsoni*) are known to breed in proximity to and likely forage in the NSMWA (CDFG 2008). Bald eagles (*Haliaeetus leucocephalus*) are infrequent visitors to the Marshes. During migration, hawks tend to follow prominent geographic features, such as the ocean shore and coast range, and the location of the NSMWA makes it attractive to these birds as they pass through (CDFG 1977).

Mudflats. Intertidal mudflats are associated with tidal sloughs and tidal marsh throughout the entire NSMWA. The mudflat extent varies daily with the tidal amplitude (elevation difference between low and high tide). Damping of the tidal signal between San Pablo Bay and the inland extremity of sloughs creates a stage lag between the time when the intertidal mudflats are exposed in each area. This lag is exploited by foraging shorebirds that move in large flocks from one mudflat to another. Shorebirds range from small to large, with bills of varying lengths and shapes, utilizing differing techniques for acquiring food. These differences make it possible for several species of shorebirds to forage in the same area.

The mudflats are by definition devoid of emergent vegetation but support an extensive algal community as well as diatoms and myriad invertebrate species such as polychaetes (marine worms), amphipods, and mollusks that provide shorebird forage. Shorebirds of NSMWA mudflats include American avocets (*Recurvirostra americana*), dunlins (*Calidris alpine*), sanderlings (*Calidris alba*), plovers, dowichers (*Limnodromus* sp.), yellowlegs (*Tringa* sp.), whimbrels (*Numenius phaeopus*), willets (*Catoptrophorus semipalmatus*), godwits (*Limosa* sp.), black-necked stilts (*Himantopus mexicanus*), and phalaropes (*Phalaropus* sp.).

At high tide, shallowly flooded areas of the NSMWA mudflats are habitat for a wide diversity of wading birds such as snowy egrets (*Egretta thula*), great egrets (*Casmerodius albus*), great blue herons (*Ardea herodias*), and black crowned night herons (*Nycticorax nycticorax*). These birds often feed on fish (piscivorous) and invertebrates in shallow water, and also forage on small vertebrates and insects in the upland areas. Of these species, great blue heron are known to nest in the NSWMA (Wyckoff 2000).

Tidal Marsh. Tidal marshes are wetlands characterized by intermittent tidal inundation and the presence of emergent vegetation such as Pacific cordgrass and pickleweed. Tidal wetlands in the NSMWA are generally brackish and found between the elevations of approximately mean tide and the higher high water. Low tidal marshes are distinguished from high tidal marshes by longer periods of inundation and differing plant communities (USACE 1999) (see **Figure 10)**. The majority of tidal marshes in the NSMWA are experiencing a cyclical progression from tidal wetland in the 1800s to diking, draining, and either salt production or agriculture in the past to the recent restoration of tidal action. Others, such as Coon Island, were restored over 50 years ago or were never diked, such as Fly Bay.

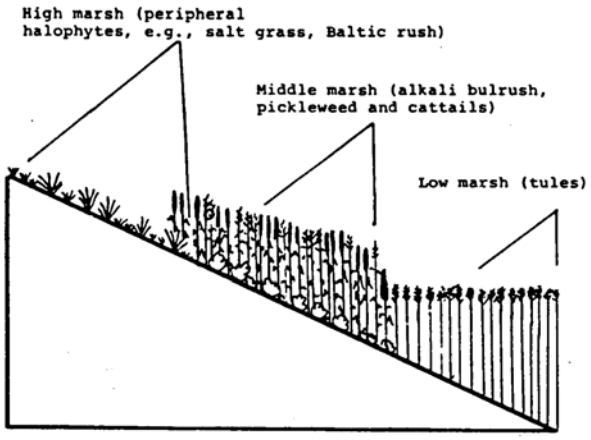

Figure 10. Representation of Brackish Tidal Marsh Zones (USFWS 1984).

Due to their tidal elevation, and typical plant cover, tidal marshes often maintain complex assemblages of invertebrates, such as amphipods, insects, and mollusks. These invertebrates provide a food source for a number of shorebirds and wading birds. Some of the most conspicuous residents of the Marshes are the rails, the most well-known of which is the American coot. At one point, the number of American coot was calculated at as many as 15,505 individuals in the NSMWA (CDFG 1977). Although less well-known than the coot, several rail species are known to breed and nest in wetland vegetation in the NSMWA, including California clapper rails, Virginia rails (*Rallus limicola*), Sora rails (*Porzana carolina*), and black rails (*Laterallus jamaicensis coturniculus*). Studies of black rails in the San Francisco Bay showed

that the majority of the population (>80%) was confined to the San Pablo Bay and associated rivers (Evens et al. 1991).

One of the few endemic species to the San Francisco Bay, the salt marsh harvest mouse, occurs in tidal marshes in the NSMWA. The salt marsh harvest mouse is generally found in the upper regions of pickleweed beds along the high tide level. It has been observed and trapped at several locations in the Marshes, including 42 mice caught over 345 trap nights at Ponds 4 and 5 of the Napa River Unit (Takekawa et al. 2005). Salt marsh harvest mice are also documented at Tubbs Island, Fly Bay, Dutchman, and South Sloughs (CDFG 1977).

Perennial Wetlands. The few scattered perennial wetlands that are not subject to tidal inundation occur in uplands of the NSMWA. These marshes typically occur along the edges of ponds**.** Perennial marshes in NSMWA are usually brackish, due to salts retained in the soils as well as the brackish nature of the groundwater. Perennial wetlands are present at American Canyon, Huichica Creek and at Wingo. The Wingo ponds were recently flooded when Sonoma Creek overtopped a levee, but will be restored once the area is dewatered and the levee repaired. Another type of perennial wetland occurs in diked baylands that are wet year round due to groundwater seepage and rainwater (Wyckoff 2000). These diked perennial marshes, such as those at the Huichica Creek unit, are dominated by saltgrass meadows. If sufficient water exists, cattails, tules, and alkali bulrush can be found (Jones and Stokes 2003).

Several of the seasonal and perennial freshwater ponds above were created to provide habitat for wintering migratory waterfowl – particularly the dabbling ducks, such as gadwalls (*Anas strepera*), pintails (*Anas acuta)*, American wigeons (*Anas americana*), shovelers (*Anas clypeata*), and cinnamon teals (*Anas cyanoptera*), which feed on algae, submerged macrophytes, and aquatic invertebrates. Diked marshes provide habitat for small mammals, terrestrial birds such as the white-crowned sparrow, and, occasionally, reptiles, such as the western fence lizard, which, in turn provide food for hawks and owls (CDFG 1977).

Seasonal Wetlands. Seasonal wetlands form in shallow topographic depressions that pond rainwater for a prolonged period of time, usually between one and six months, and behind dikes or levees in areas once subject to tidal inundation. The position that seasonal wetlands occupy in the landscape gives rise to other commonly used names: diked baylands or diked historic tidelands. The seasonal wetland vegetation community depends greatly on soil salinity and the length of seasonal inundation (USACE 1999). Water sources for these wetlands include rainwater, runoff and groundwater seepage. Seasonal wetlands are usually dry at least 3 months of the year. Both small and large mammals, such as brush rabbit, jackrabbit, raccoon, skunk, Norway rat, house mouse, and vole often use these areas, thus birds of prey often exploit these disturbed wetlands. Similar to perennial wetlands, waterfowl—particularly dabbling ducks—are often observed foraging in the seasonal wetlands of the NSMWA.

Upland Habitats

The upland habitats of the NSMWA are comprised of grasslands, levees, non-native tree stands, and riparian zones. They differ from wetlands in that they provide habitat that is not typically inundated with water. As a result, upland plants do not have the physiological mechanisms to process salt or anoxic soils. The differing plant communities of the uplands provide the resources necessary to maintain an abundant prey base that includes small mammals, insects, reptiles and amphibians.

The grassland and levees of the NSMWA provide breeding, hunting and shelter for brush rabbit, black-tailed jackrabbit, muskrat, raccoon, long-tailed weasel, striped skunk, Norway rat, the house mouse, California vole (*Microtus* sp.) and California ground squirrel (CDFG 1977), while red-tailed hawks, kestrels (*Falco sparverius*), and owl hunt for prey in upland areas of the NSMWA (CDFG 1977).

A wide variety of land birds nest and forage on levees, tidal marshes, structures, and upland grasslands of the NSMWA. Species include blackbirds (Icteridae family), sparrows and finches (Fringillidae family), swallows (Hirundinidae family), flycatchers (Tyrannidae family), and horned larks (*Eremophila alpestris*). Upland game birds include ring-necked pheasants (*Phasianus colchicus*), quail (*Callipepla californica*), wild turkeys (*Meleagris* sp.), and mourning doves (*Zenaida macroura*). San Francisco common yellowthroats (*Geothlypis trichas sinuosa*) and Samuel's song sparrows (*Melospiza melodia samuelis*) both breed in the NSMWA.

Grasslands. Grasslands in the NSMWA were once dominated by native perennial grasses interspersed with native annual and perennial forbs. Intensive agricultural and grazing use of grasslands has altered the species composition of grasslands in the NSMWA, resulting in dominance by introduced European annual and perennial grasses and exotic forbs. A few native grass and forb species remain in the NSMWA grasslands, particularly the uplands of the Huichica Creek Unit. A recent restoration project in the uplands of this Management Unit reintroduced native plant species, which are thriving today (see **Table 2-2**).

A grassland subcategory is moist grasslands, usually occurring along the ecotone between wetlands and upland grasslands. These areas typically have hydric soils and are typically saturated in the upper 12 inches. Dominant plant species are tolerant of moister soils that those of annual grasslands. Grasslands provide important nesting and foraging habitat for many passerine birds and raptors, small and large mammals, reptiles, and amphibians.

Levees. Levees are found throughout the NSMWA. These man made structures provide important nesting, refuge and resting habitat for numerous birds, reptiles, and small mammals (Jones and Stokes 2004a). Lower elevation levee sections typically support upper marsh plant communities. Higher elevations, above tidal influence, typically support riparian and upland species. Windrows of planted trees occur along some levees in the Napa River, Huichica Creek, and Southern Crossing Unit, and several nonnative plants have invaded some levees in the NSMWA.

Relatively few waterfowl (in proportion to the number migrating) nest in the Marshes, but common nesting species include gadwalls, pintails, mallards (*Anas platyrynchos*), cinnamon teals, and ruddy ducks (*Oxyura jamaicensis*), which nest on the heavily vegetated levees of the NSMWA (Wyckoff 2000). Like waterfowl, most shorebirds are migratory in the NSMWA. Shorebirds that nest on levees in the Marshes include American avocet, black-necked stilt, western snowy plover (*Charadrius alexandrinus nivosu)* and California least tern (*Sterna antillarum browni)*..

Non-native Trees. Stands of non-native trees can be found along levees and upland areas in the NSMWA. Eucalyptus (*Eucalyptus* spp.) are the most common of these trees species; other trees include acacia (*Acacia* spp.) and black locust (*Robinia pseudoacacia*).

Some standing dead Eucalyptus trees on levees were killed as preventative levee maintenance, while others have died or are stunted by the Eucalyptus longhorn borer (Brady/LSA 1998). These stands provide roosting habitat for raptors and other birds, including egrets, cormorants, and red-tailed hawks (*Buteo jamaicensis*).

Riparian

Riparian habitat is present along the edges of streams in the NSMWA. Waterways where riparian habitat is present include Huichica Creek, Tolay Creek, Sonoma Creek and American Canyon Creek. The majority of riparian vegetation associated with waterways in the NSMWA was established within the last 15 years through restoration efforts. Vegetation communities in riparian corridors and on levees may comprise multiple strata, providing more complex cover and wildlife habitat. Riparian habitat of the NSMWA provides key nesting opportunities to many land birds such as blackbirds, sparrows, finches, and swallows. Other species found here may include woodpeckers, flycatchers, horned larks, and many other species of songbirds (CDFG 1977).

Other Habitat Types

Open Water; Rivers, Sloughs and Bays. Open water habitat is present in the NSMWA in the form of ponds, creeks, sloughs, bays, and rivers. These features are void of emergent vegetation but may contain submerged vegetation that provides crucial food sources for fish, waterbirds, and aquatic invertebrates. Open waters are utilized by juvenile fish as a nursery grounds and resting place for both dabbling and diving ducks. Species distributions in open water habitats are strongly tied to salinity gradients.

Diving ducks, including scaups (*Aythya* spp.), canvasbacks (*Aythya* sp.), and other diving waterbirds, such as Western grebes (*Aechmophorus occidentalis*), feed in deep water on benthic invertebrates. Canvasbacks in particular are an important species in the area, because a substantial portion of their population winters in San Francisco Bay. Approximately 25% of all canvasbacks in North America are found along the Pacific Flyway in January, and the majority of these are found in San Francisco Bay and its associated marshes and estuaries (Jones and

Stokes 2003a). In addition, dabbling ducks, such as gadwalls (*Anas strepera*), pintails (*Anas acuta)*, American wigeons (*Anas americana*), shovelers (*Anas clypeata*), and cinnamon teal (*Anas cyanoptera*) feed on algae, submerged macrophytes, and aquatic invertebrates in shallower waters.

North American river otters (*Lontra canadensis*) are found occasionally in creeks and upper reaches of sloughs. Harbor seals (*Phoca vitulina*) have been observed in Tolay Creek, at Tubbs Island, as well as the mouth of Napa Slough at the Napa River and south of Coon Island. DFG staff has osbserved numerous harbor seals associated with recently breached ponds of the Green Island Unit. A rare occurrence of the California sea lion (*Zapholus californianus*) was observed in Sonoma Creek by DFG staff. Sea lions were common at one time in the lower Napa River; they were frequently observed using a haul out near Catalina Circle of the White Slough Unit.

Managed Former Salt Ponds. At one time, there were more than 8,000 acres of salt ponds used for salt production in the North Bay. These salt ponds had extremely high salinities that most vascular plants could not cope with. Wigeon grass was one of the few vascular plants that could withstand this condition, and could thus be observed in several ponds. While not favorable to vascular plants, these salt ponds provided beneficial habitat to phytoplankton, water-boatman, copepods, fairy shrimp, brine shrimp and other invertebrates (CDFG 1977). Today, these former salt ponds are managed or are slated to be managed for wildlife use. Water levels in the majority of the salt ponds in the NSMWA are controlled through manipulation of tide gates and other water control structures by DFG staff. Managed ponds include Ponds 1/1A, 2, 6/6A, 7/7A, and 8.

The Napa-Sonoma Marshes were designated as a “Globally Important Bird Area” by the American Bird Conservancy because a large proportion of the shorebirds and waterfowl in the greater San Francisco estuary are found in the former salt pond habitats of that region (Takekawa et al. 2000). The types of birds that utilize the ponds are correlated with water depth, salinity, and size of ponds (Jones and Stokes 2004a). During recent surveys of several of the former salt ponds in the NSMWA, 80 species of birds were recorded and over 900,000 individual birds were estimated to have used the ponds over a three-year period (Takekawa et al. 2005).

3.8.2.2 Habitat Descriptions by Management Unit

American Canyon Unit

Tidal Marsh. The Napa River flows into the American Canyon Unit through several levee breaches on the east boundary of the unit. Fragments of tidal marsh occur along the outboard side of the Napa River levees. The tidal marshes of the American Canyon Unit were once diked, isolating them from tidal action. Several accidental and purposeful breaches in the levee along the Napa River have occurred in the last 20 years, partially restoring tidal action and facilitating tidal marsh establishment. In addition, a restoration project was implemented in 1990 in this Unit, in part to restore topography to encourage the reestablishment of tidal marsh vegetation. This area, on the north side of American Canyon Creek, is now dominated by tidal marsh

vegetation. Plant species of the American Canyon Unit tidal marsh include Pacific cordgrass, hardstem bulrush, Alkali bulrush, narrow-leafed cattail (*Typha angustifolia*), pickleweed, and gumplant.

Perennial Wetland. As part of the restoration project mentioned above, a freshwater perennial wetland was created that is maintained with water from American Canyon Creek. This perennial wetland consists of an open water pond surrounded by dense cattails and tule. A berm across American Canyon Creek with an open culvert directs creek flow to the pond and marsh and water is retained and the discharge elevation controlled using four standpipes with weir boards.

Perennial wetland at American Canyon Unit (photo by: URS)

Grassland. Annual mesic and moist grassland (e.g., creeping wild rye [*Leymus triticoides*]) occur along the east side of the American Canyon Unit. Moist grasslands occur in the transition zone between wetlands and upland annual grasslands. Scattered shrubs and small trees are scattered in the annual grasslands of this unit.

Riparian. Riparian habitat occurs along American Canyon Creek in this unit. Vegetation along the creek includes willow (*Salix* sp.), oak, elderberry, toyon, and cottonwood (*Populus* sp.). Most of the vegetation that is present today is a result of a large scale restoration project implemented as mitigation in 1990. Along the creek a large floodplain was excavated as part of restoration efforts.

Open Water, Rivers, Sloughs, and Bays. Approximately half of the American Canyon Unit is the open water of the Napa River. Open water is also present along American Canyon Creek.

Coon Island Unit

Tidal Marsh and Mudflats. The mature tidal marshes of Coon Island have been relatively undisturbed for the past 50 years. Coon Island has low, middle, and high elevation marsh. Low-elevation marshes at Coon Island support cordgrass along the Napa Slough. Mid-elevation vegetation includes tules. Cattails and tule border the sloughs of the north and west sides of the island where the channels are too steep-sided to support cordgrass (CDFG 1975). The higher elevation marsh supports patches of alkali bulrush, three-square bulrush, Baltic rush (*Juncus balticus*), saltgrass, Pacific silverweed (*Potentilla anserina* ssp. *pacifica*), arrow grass, and brass buttons (*Cotula coronopifolia*) (CDFG 1975).

Grassland. Several small mounds of land seldom subject to tidal inundation occur on the Island. Vegetation of these areas includes gumplant, coyotebrush (*Baccharis pilularis*), saltbush (*Atriple* sp.) dock and upland grasslands (CDFG 1975).

Huichica Creek Unit

Seasonal Wetland. Seasonal marshes occur in diked, former salt ponds in the Huichica Creek Unit. Water in the seasonal marshes comes primarily from rainwater and runoff. The seasonal marshes are very disturbed, typically dominated by non-native plant species with little differentiation in plant communities due to lack of topographic variation resulting from past land use. Non-native plants include perennial pepperweed and mustard.

Tidal Marsh. Tidal marsh in the Huichica Creek Unit is present in the Fly Bay subunit, along Hudeman Slough, and on the outboard side of levees of the former salt ponds along tidal sloughs.

Perennial Wetland. Several freshwater ponds are scattered in the uplands of the Huichica Creek Unit, surrounded by perennial wetland vegetation. These ponds are brackish due to the high salinity of the groundwater and soils. Vegetation includes dense tule and cattail.

Mudflats. Mudflats are present in portions of the Huichica Creek Unit during low tide.

Grassland. Annual grasslands occur in the uplands of the Huichica Creek Unit. The grasslands are primarily dominated by non-native annual grasses and forbs. Perennial invasive, non-native grasses occur in scattered patches in the annual grasslands, including Pacific bentgrass (*Agrostis avenacea*) and Harding grass (*Phalaris aquatica*). A 25-acre grassland restoration was completed in 2003 in the uplands of Huichica Creek, and such natives as purple needlegrass, California oatgrass (*Danthonia californica*) and lupine (*Lupinus* sp.) persist.

Levees. There are extensive levees in the Huichica Creek Unit, surrounding and bisecting former salt ponds and along the edges of the diked seasonal and perennial wetlands. Iceplant and scrub vegetation is common on former pond levees. Levees of diked seasonal and perennial wetlands contain dense infestations of perennial pepperweed and other invasive weeds.

Restored grasslands at Huichica Creek Unit (photo by: Greg Green)

Open Water; Rivers, Sloughs, and Bays. Open water of rivers, sloughs, and bays exist in Huichica Creek, Fly Bay, Hudeman Slough,

and diked managed ponds of the Huichica Creek Unit.

Managed Former Salt Ponds. Several former salt ponds fall within the Huichica Creek Unit, including Ponds 7, 7A, and 8. Currently, Pond 7 contains bittern with little to no vegetation. Water depth is dependent on precipitation and operation of water control structures in Ponds 7 and 8, but levels were historically maintained by Cargill at 0.5 to 4.5 feet deep (Jones and Stokes 2003a).

Green Island Unit

Seasonal Wetlands. Seasonal wetlands occur within the Green Island Unit along the railroad corridor where adjacent swales and drainage ditches were created to aid in controlling storm water runoff, in drainage channels, and in former tidal wetlands (diked marsh) that have not been drastically disturbed by salt-making activities (URS 2006b). In addition, two seasonal wetland areas are located outside the eastern salt pond levees.

Tidal Wetlands. Tidal wetlands in the Green Island Unit are limited to the margins of the barge channel in the Napa Plant Site, and the outboard side of riverfront levees (URS 2006b).

Mudflats. A large mudflat (approximately 190 acres) exists immediately southwest of the Green Island Unit in the intertidal zone between the salt pond levees and the subtidal channel of the Napa River (URS 2006b).

Levees. Levees extend for miles and cover an area of over 150 acres in the Green Island unit. The largest levees form the perimeter of the unit. Smaller “internal levees” form the boundaries of the salt ponds and water conveyance channels. The levees are constructed primarily from native bay mud material. The outboard face of the perimeter levee is armored with concrete and other structural debris. The vegetation type on the levees varies with elevation. The highest and driest portions of the perimeter levee are dominated by non-native, ruderal species, especially wild radish. Lower, mesic portions of the levees are dominated by nonnative, iceplant species (*Carpobrotus* sp. and *Mesembryanthemum nodiflorum*). A Eucalyptus tree corridor lines some reaches of the toe drain outboard of the eastern perimeter levee.

Managed Former Salt Ponds. The Green Island Unit consists of two subunits; Central and South. The Green Island Unit contains several former salt ponds, as well as an extensive network of water conveyance channels. Restoration in the Central Unit of the Green Island Unit began in 2008, with the first levee breach in September of 2009. Restoration construction in the South Unitis scheduled for 2010.

Napa River Unit

Tidal Marsh. Tidal marsh vegetation is present in Pond 2A and on the on the outboard sides of levees, largely on accreted sediments (Jones and Stokes 2003a). Outboard levee tidal wetland vegetation is up to 100 feet wide and well established. Tidal marshes in Pond 2A have quickly become established since its breaching in 1995 and 1997. Of particular note is the Napa Centennial tidal marsh located on the outboard side of the levee of Pond 4 of the Napa River Unit along the Napa River. This small ancient tidal wetland was never diked nor used for farming or salt making.

Native cordgrass along Napa Slough

Mudflats. Mudflats are exposed during low tide in tidal sloughs of the unit, as well as in the managed former salt ponds when water is drawn down by DFG staff.

Levees. Extensive levees rim the former salt ponds of the unit. In some areas the levees are heavily vegetated, dominated by ruderal species and scrub. Coyotebrush, toyon, Himalayan blackberry, Eucalyptus, perennial pepperweed, iceplant, and yellow star thistle are present on levees in this unit (Jones and Stokes 2003a).

Open Water; Rivers, Sloughs and Bays. Sloughs of the Napa River Unit provide open water habitat during higher tides.

Managed Former Salt Ponds. The water levels of Ponds 6, 6A, Little Island Farms subunit, 1, 1A, and 2 are currently managed by DFG staff to control salinity levels and to optimize wildlife habitat. Salinities of each pond vary according to the water year, distance from the San Pablo Bay and depth.

Ringstrom Bay Unit

Tidal Marsh. Water flows within the tidal marshes at Ringstrom Bay are controlled via water control structures by DFG staff. Reclaimed water from the Sonoma Valley County Water Agency is also pumped into the tidal marshes during emergencies or when storage problems arise. Tidal marsh is the dominant habitat type in this unit, interspersed with open water of sloughs and mudflats.

Mudflats. Mudflats occur in association with tidal sloughs and tidal wetlands in this unit.

Tidal slough in Ringstrom Bay

Seasonal Wetland. Seasonal wetlands in this unit are separated from tidal wetlands by levees. A recent restoration project enhanced seasonal freshwater wetlands through excavation, recontouring, and levee repair.

Grassland. Annual mesic and moist grasslands are present along the northwestern boundary of this unit. These grasslands are highly disturbed; they were likely used for oat hay farming in the past and are now seeded with crop species by DFG for wildlife forage.

Levees. Levees of this unit are vegetated with annual and perennial non-native forbs, grasses and coyotebrush. Low, middle and high marsh vegetation are present. The tidal wetlands and open water of this unit support a wide diversity of birds and wildlife, including ducks, raptors, beavers, and otters.

Open Water; Rivers, Sloughs and Bays. Open water occurs interspersed with tidal marsh and mudflats in the Ringstrom Bay Unit.

Sonoma Creek Unit

Tidal Marsh. The Sonoma Creek Unit, also known as West End, in part, contains tidal marsh vegetation interspersed with open water. Tidal waters enter this unit through a gate that is left fully open at all times to allow tidal exchange (Huffman 2008a). A levee separates the west and east sides of West End, however, a breach in the levee allows mixing of water between the two sections (Huffman 2008a). Sediment is rapidly accreting in this unit. A notable characteristic of these tidal wetlands is the dominance of annual pickleweed (*Salicornia* spp.), a species not common to the rest of the NSMWA.

Tidal marsh dominated by annual pickleweed species at Sonoma Creek Unit (photo by: URS)

Mudflats. Mudflats are present along the southern boundary where the Sonoma Creek Unit borders San Pablo Bay. Mudflats area relatively extensive in this unit, in part due to the rapid siltation rate (Huffman 2008a)

Levees. Levees of this unit are vegetated with annual and perennial non-native forbs, grasses and extensive coyotebrush.

Southern Crossing Unit

Seasonal Wetland. Seasonal wetlands occur in areas of diked historic tidelands with salty soils at the Southern Crossing Unit. Dominant species include pickleweed (perennial), alkali heath (*Frankenia salina*), salt grass, and brass buttons. Other species present include fat hen (*Atriplex triangularis*), rabbit's foot grass (*Polypogon monspeliensis*) and bird's foot trefoil. The vegetation occurs in a mosaic of patches with bare ground or in stands of 100% cover (Brady/LSA 1998).

View of northern edge of Southern Crossing Unit

Tidal Marsh. Tidal marsh vegetation within the Southern Crossing Unit occurs along the Napa River mostly outboard of the levee but also in a few places inboard of the levee. Dominant species include alkali bulrush, California bulrush, fat hen, gum plant, and salt grass. Areas that are not inundated as frequently support bird's foot trefoil, Italian rye grass (*Lolium* sp.), and rabbit's foot grass (Brady/LSA 1998). Salt marsh harvest mouse and Mason's lilaeopsis (*Lilaeopsis masonii*) are known to occur in the Southern Crossing Unit in tidal marsh habitat (Brady/LSA 1998).

Grassland. Mesic grasslands occur in Southern Crossing Unit, in a mosaic with seasonal salt marsh and bare ground. Dominant species include meadow barley (*Hordeum brachyantherum*), Mediterranean barley, Italian ryegrass (*Lolium multiflorum*), Harding grass, hair grass (*Deschampsia danthonioides*) and California semaphore grass (*Pleuropogon californicus*). The grass species occur in either single species stands or mixed with other species of grasses or forbs. Forbs present include alkali mallow (*Malvella leprosa*), knotweed (*Polygonum arenastrum*), brass buttons, hyssop loosestrife (*Lythrum hyssopifolium*), and birdsfoot trefoil (*Lotis corniculatus*) (Brady/LSA 1998).

Levees. The levees of the Southern Crossing Unit are both unvegetated and vegetated; the levee along the Napa River is vegetated with Eucalyptus trees.

Non-native Trees. Eucalyptus stands occur along the Napa River levee of the Southern Crossing Unit. The trees of this stand appear to be stunted and exhibit dieback on the branches. Understory vegetation is dominated by nonnative grasses and forbs (Brady/LSA 1998).

Tolay Creek Unit

Seasonal Wetlands. Seasonal wetlands occur in the northern portion of the Tolay Creek Unit. These areas were once exposed to tidal action but now are isolated from the tide. These seasonal wetlands are highly saline due to remnant soil salts. Vegetation includes pickleweed, saltgrass, and perennial pepperweed. Small ponds occur in the eastern portion of the northern section of the Tolay Creek Unit; water is supplied largely from one of the small Tolay Creek tributaries that enters the unit directly across from the Infineon Raceway.

Tidal Marsh. Tidal marsh habitat in Tolay Creek Unit is limited to the outboard side of a levee that runs along the former Tolay Creek alignment. Tidal wetland likely was more extensive when Tolay Creek was connected to Sonoma Creek. These areas of former tidal marsh are now seasonal wetlands that are salty due to remnant saline soils. The outboard side of the eastern levee that borders the unit receives very little tidal input due to heavy channel siltation.

Tidal marsh at White Slough Unit

Grassland. Highly disturbed moist grassland occurs adjacent to seasonal wetlands in the northern portion of the Tolay Creek Unit. These grasslands are interspersed with seasonal wetlands.

Riparian. A limited amount of riparian habitat occurs in the Tolay Creek Unit along Tolay Creek north of SR 37. Willow scrub lines the small freshwater side channel of Tolay Creek. Beavers are active in the area (Huffman 2008a)

Open Water; Rivers, Sloughs and Bays, Levees and Mudflats. The southern portion of the Tolay Creek Unit is predominantly open water and intertidal mudflat. A few levees fall within the unit, but the majority the levees are managed by the USFWS. Tidal marsh vegetation also exists along the inboard side of levees, but these areas are also managed by the USFWS.

White Slough Unit

Seasonal Wetland. Seasonal wetlands are limited in the White Slough Unit. A seasonal wetland pond was created in the uplands of the White Slough Unit in 1989 as a part of a mitigation

project funded by the City of Vallejo. In the past, this seasonal wetland supported species typically associated with vernal pools, including flatface downingia (*Downingia pulchella*) and California eryngo (*Eryngium aristulatum*) (Demgen 2008).

Tidal Marsh and Levees. Tidal marsh and associated tidal channel is the dominant habitat type in the White Slough Unit, occurring north of SR 37. The primary tidal channel leads to multiple large-diameter culverts under SR 37 that supply water to the southern White Slough area that is not owned by DFG but is noteworthy because the tidal prism flowing into the southern area will minimize siltation in this channel.

Grassland. Grasslands are interspersed with the tidal wetland vegetation and bare ground in the higher marsh plain on the White Slough Unit. Dominant species include ryegrass and Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*).

Wingo Unit

Seasonal Wetland (planned). Sonoma Creek overtopped a levee of the Wingo Unit in 1998 and again in 2006, causing flooding of the entire Unit. The levee was repaired and the Unit dewatered in 2008. Seasonal wetlands associated with ponds in the Wingo Unit were present prior to flooding. These ponds were created in uplands to increase habitat diversity for a variety of bird species. The seasonal wetlands and ponds will be restored once the water is pumped out of the Wingo Unit and the levee is repaired.

Open Water; Rivers, Sloughs and Bays and Levees. Levees surrounding and bisecting the Wingo Unit are vegetated by typical ruderal vegetation and scrub species.

3.8.3 Fisheries and Aquatic Invertebrates

3.8.3.1 Fisheries

This section summarizes the current conditions for fisheries resources in the NSMWA. It discusses native and nonnative fish use of marshes, aquatic habitats, and special-status fish species.

NSMWA supports a wide variety of fisheries resources and provides vital fish spawning, rearing, and/or migratory habitat for a diverse assemblage of native and non-native fish species. Due to its location and the variety of habitats present, many species can be expected to occur in NSMWA during one or more life stages. The fisheries habitat within the NSMWA consists of a series of sloughs adjacent and connecting to San Pablo Bay, as well as a series of managed ponds. These areas provide habitat for a variety of fish species. In particular, the sloughs provide nursery habitat for many estuarine fish species (e.g., striped bass). Some species, such as shiner perch, would be expected to occur in portions of NSMWA that are located along San Pablo Bay that provide open water and mudflat habitat. Several perennial stream systems flow through

NSMWA (Napa River, Sonoma, and Tolay creeks). Anadromous fish species such as steelhead (*Oncorhynchus mykiss*), Chinook salmon (*O. tshawytscha*), and striped bass (*Morone saxatilis*) can be expected to migrate through the project area. Some freshwater fish species not normally expected to occur within the Marshes (e.g., California roach [*Hesperoleucus symmetricus*]) may be carried downstream during high flows from upstream freshwater habitats such as the upper Napa River. Other uncommon fish species to the NSMWA include the bat ray (*Myliobatis californica*), observed in the Napa River as well as the intake pond area of the Napa River Unit.

Fish species can be separated into five broad types: nondependent marine, dependent marine, true estuarine, diadromous, and freshwater (Moyle and Cech 1982). Examples of fish species within each of these categories that could be found in the NSMWA are described below (Jones and Stokes 2004b).

Nondependent marine fishes are those species, commonly found near the oceanic mouth of the estuary, that are not dependent on the estuary to complete their life cycles. Examples of such species in San Pablo Bay are shiner perch (*Cymatogaster aggregata*) and starry flounder (*Platichthys stellatus*).

Dependent marine species need the estuary to complete at least one of their life stages. This need can be for spawning, for rearing of young, or for feeding grounds for adults. An example of a dependent marine species is Pacific herring (*Clupea harengus*), which uses San Pablo Bay for spawning and rearing its young.

True estuarine species complete their entire life cycles in the estuary. In the Napa-Sonoma Marsh, delta smelt (*Hypomesus transpacificus*) are a true estuarine species.

Diadromous fishes are those that migrate through estuaries on their way either to fresh water or to saltwater. There are two types: anadromous species that migrate from saltwater to spawn in fresh water and catadromous species that migrate from fresh water to spawn in the ocean. Young of both types may spend considerable time in estuaries, taking advantage of abundant food (Moyle 2002 in Jones and Stokes 2004b). The most well known species in San Pablo Bay and the surrounding estuarine habitats grow to maturity in the ocean and spawn in fresh water. Examples are chinook salmon, steelhead, and striped bass. There are no catadromous species.

Freshwater species are those that complete their entire life cycles in the upper, tidally influenced reaches of the estuary. An important example in NSMWA is the Sacramento sucker (*Catostomus occidentalis)*.

Numerous biological and abiotic factors influence the presence, abundance, and distribution of fish species within the San Francisco Bay-Delta estuary (Moyle and Cech 1982). Physical and chemical properties, including temperature, salinity and dissolved oxygen levels are important factors that determine the special and temporal distribution of fish species within the estuary. The Sacramento-San Joaquin River system, as well as flow from the Petaluma and Napa Rivers and Sonoma and Tolay Creeks, provides essential nutrients and freshwater input that causes the

spatial and temporal variation in salinity and temperature that allows for such an abundance of species within San Pablo Bay. Freshwater input from the Napa River, and Sonoma and Tolay Creeks provides upstream freshwater spawning and rearing habitat for anadromous fish. These complexities result in a high number of species expected to occur within the NSMWA.

Fisheries Assemblage

The fisheries assemblage within the NSMWA can be effectively broken into three general habitat types: San Pablo Bay, the internal sloughs and ponds, and riverine habitat contained within Napa River, and Sonoma and Tolay Creeks. The fisheries assemblage of each is discussed in detail below.

San Pablo Bay

San Pablo Bay is a shallow estuarine bay at the north end of San Francisco Bay. Habitat in San Pablo Bay within the Napa-Sonoma Marshes Wildlife Area includes open bay, mud flats, and tidal marshes. Many fish species utilize these habitats for foraging, rearing, and migration corridors.

DFG has conducted annual fish sampling within San Pablo Bay for over 20 years, beginning in 1980 (CDFG 1999). Thirty-one species accounted for 98.9% of the total catch. They are presented in **Table 3-4** in order of decreasing total catch.

While the 31 species described above represented 98.9% of the total catch of DFG surveys, other species are known to occur within San Pablo Bay (e.g., white sturgeon) and would be expected within NSMWA.

The Management Units along San Pablo Bay include the Sonoma Creek (West End) and Ponds 1 and 1A of the Napa River Unit and South Tolay Unit. These units abut San Pablo Bay, containing both mudflat and tidal marsh habitats. The Sonoma Creek Unit contains some open water and mudflat habitat along San Pablo Bay.

Internal Sloughs and Ponds

The internal sloughs (tidal channels) and ponds provide important spawning and nursery habitat for a variety of species. Nearly all of the Management Units contain some interior slough and pond habitat. Several species, including Sacramento splittail and several goby species, spawn within the tidal channels of the NSMWA while also utilizing these habitats for rearing. Other species occur within these habitats for refuge but spawn elsewhere (e.g., striped bass).

During a one-year study of Ponds 1, 2, 3, 4, and 7 within NSMWA, 16 species were collected, including 9 native and 7 non-native species (Takekawa et al. 2000) (**Table 3-5)**.

Table 3-4. Fish commonly collected in San Pablo Bay between 1980 and 2002.

Common Name	Scientific Name	Native or Introduced
Northern anchovy	*Engraulis mordax*	Native
Longfin smelt	*Spirinchus thaleichthys*	Native
Pacific herring	*Clupea pallasii*	Native
White croaker	*Genyonemus lineatus*	Native
English sole	*Parophrys vetulus*	Native
Yellowfin goby	*Acanthogobius flavimanus*	Introduced
Pacific staghorn sculpin	*Leptocottus armatus armatus*	Native
Striped bass	*Morone saxatilis*	Introduced
Bay goby	*Lepidogobius lepidus*	Native
Jacksmelt	*Atherinopsis californiensis*	Native
Plainfin midshipman	*Porichtus notatus*	Native
Shiner perch	*Cymatogaster aggregata*	Native
Speckled sanddab	*Citharichthys stigmaeus*	Native
Starry flounder	*Platichthys stellatus*	Native
Topsmelt	*Atherinops affinis*	Native
Arrow goby	*Clevelandia ios*	Native
Chinook salmon	*Oncorhynchus tshawystcha*	Native
American shad	*Alosa sapidissima*	Introduced
Threespine stickleback	*Gasterosteus aculeatus*	Native
Brown smoothhound	*Mustelus henlei*	Native
Dwarf surfperch	*Micrometrus minimus*	Native
Cheekspot goby	*Ilypnus gilberti*	Native
Surf smelt	*Hypomesus pretiosus*	Native
Bay pipefish	*Sygnathus leptorhynchus*	Native
Walleye surfperch	*Stizostedion vitreum*	Native
Inland silverside	*Menidia beryllina*	Introduced
Threadfin shad	*Dorosoma petenense*	Introduced
Delta smelt	*Hypomesus transpacificus*	Native
Brown rockfish	*Sebastes auriculatus*	Native
California halibut	*Paralichthys californicus*	Native
California tonguefish	*Symphurus atricauda*	Native

Table 3-5. Fish collected in former salt ponds and associated internal sloughs at the NSMWA.

Common Name	Scientific Name	Native or Introduced
American shad	*Engraulis mordax*	Introduced
Delta smelt	*Hypomesus transpacificus*	Native
Inland silverside	*Menidia beryllina*	Introduced
Longjaw mudsucker	*Gillichthys mirabilis*	Native
Northern anchovy	*Engraulis mordax*	Native
Pacific staghorn sculpin	*Leptocottus armatus armatus*	Native
Rainwater killifish	*Lucania parva*	Introduced
Sacramento splittail	*Pogonichthys macrolepidotus*	Native
Starry flounder	*Platichthys stellatus*	Native
Striped bass	*Morone saxatilis*	Introduced
Striped mullet	*Mugil cephalus*	Native
Threadfin shad	*Dorosoma petenense*	Introduced
Threespine stickleback	*Gasterosteus aculeatus*	Native
Tridentiger goby sp.	*Tridentiger* sp.	Introduced
Tule perch	*Hysterocarpus traski*	Native
Yellowfin goby	*Acanthogobius flavimanus*	Introduced

The species listed in **Table 3-5** are not inclusive and many other fish species would be expected to occur within the internal sloughs and pond habitat within NSMWA. These include species that may be moving through these habitats, as well as resident species or those utilizing the habitat for rearing.

Riverine Habitat

Riverine habitat within the NSMWA is present within the Napa River and the Sonoma, Tolay, Huichica, and American Canyon creeks. These streams include freshwater habitat in their upper reaches, used for steelhead spawning in the larger watersheds, and estuarine species in the lower reaches. Management units with riverine habitat include the Tolay Creek Unit, Sonoma Creek Unit (West End), Wingo Unit, Napa River Units [Pond 3 (Knights Island), Ponds 4, 5 (Russ Island)], Huichica Creek Unit, Coon Island Unit, Southern Crossing Unit, American Canyon Unit, White Slough Unit, and adjacent to the Green Island Unit. The five stream systems are discussed in detail below.

Napa River

The Napa River watershed provides habitat for a variety of fish species. A total of 42 fish species were reported in DFG, U.S. Environmental Protection Agency (USEPA) documents, and the Napa River Monitoring database (Napa County 2005). Twenty-two native fish species have been collected in the Napa River watershed, including the following species of interest: steelhead, fall-run Chinook salmon, Pacific lamprey, delta smelt, and Sacramento splittail (**Table 3-6**). No fish population data are available for Huichica Creek or American Canyon Creek; therefore, these creeks are not included in **Table 3-6**. Several freshwater reservoirs are located upstream. Historically, the Napa River supported a run estimated to be between 6,000 and 8,000 steelhead and between 2,000 and 4,000 coho salmon (USFWS 1968). Coho have been extirpated from the watershed (USFWS 1968), and the steelhead population has declined to an estimated run of less than a few hundred spawning adults (Stillwater Sciences 2002). The historical status of Chinook salmon in the Napa River is not as well known. However, hydrologic and habitat conditions in the Napa River suggest that Chinook were present historically. Furthermore, recent collections of juvenile Chinook salmon in the Napa River suggest that successful reproduction occurs under present conditions (USACE 2004b). Fall-run Chinook salmon were historically present in Sonoma Creek, which is adjacent to the Napa River and contains similar habitat and hydrology to the Napa River (Sonoma Ecology Center 2002). This further suggests that Chinook were historically present in the Napa River. In addition, the Napa River supports runs of anadromous striped bass, white sturgeon, and American shad.

The reason for the decline in the number and diversity of native fish is complex and includes competition from nonnative species and anthropogenic changes in the watersheds. Twenty species of non-native fish have been collected in the Napa River. Exotic fish introductions have impacted most freshwater ecosystems in California and have dramatically altered food web dynamics and the species composition of many fish communities (Moyle 2002). Human induced changes to habitat and stream hydrology often result in changes to existing fish communities. For example, the shift of a river system from a pool-riffle morphology to a morphology dominated by large, deep pools with increased water temperatures and slow-moving water often provide the preferred habitat of predatory fish species, many of which are exotic, such as largemouth bass (Stillwater Sciences 2002).

Sonoma Creek

Sonoma Creek flows through the NSMWA before entering San Pablo Bay. A run of steelhead are known to occur in Sonoma Creek and was estimated to be approximately 1,200 spawning adults in 1965. There is conflicting evidence as to whether coho salmon were historically present within Sonoma Creek. However, there is no evidence to suggest that they currently utilize this stream, and therefore are not likely to occur in Sonoma Creek (Jones and Stokes 2004a).

During fish surveys of Sonoma Creek between 1992 and 1998, 15 fish species were collected (**Table 3-5**), consisting of 10 native species and 5 non-natives (Leidy 1999). These surveys are

not inclusive and it is expected that many of the fish species found within the San Pablo Bay and interior sloughs and pond habitats would be found within portions of Sonoma Creek.

Table 3-6. Fish species collected in the Napa River, Sonoma Creek, and Tolay Creek Watersheds.

Common Name	Scientific Name	Napa River	Sonoma Creek	Tolay Creek
Native Species				
Arrow goby	*Clevelandia ios*	—	—	X
Bay goby	*Lepidogobius Lepidus*	—	—	X
Bay pipefish	*Sygnathus leptorhynchus*	—	—	X
California roach	*Hesperoleucus symmetricus*	X	X	—
Chinook salmon	*Oncorhynchus tshawystcha*	X	—	—
Chum salmon	*Oncorhynchus keta*	X	—	—
Delta smelt	*Hypomesus transpacificus*	X	—	—
Hardhead	*Mylopharodon conocephalus*	X	—	—
Longjaw mudsucker	*Gillichthys mirabilis*	X	X	—
Pacific herring	*Clupea pallasi*	—	—	X
Pacific lamprey	*Lampetra tridentata*	X	X	—
Pacific staghorn sculpin	*Leptocottus armatus*	X	—	X
Prickly sculpin	*Cottus asper*	X	X	—
Riffle sculpin	*Cottus gulosus*	X	X	—
Sacramento pikeminnow	*Ptychocheilus grandis*	X	X	—
Sacramento splittail	*Pogonichthys macrolepidotus*	X	—	—
Sacramento sucker	*Catostomus occidentalis*	X	X	—
Speckled sanddab	*Citharichthys stigmaeus*	—	—	X
Steelhead/ rainbow trout	*Oncorhynchus mykiss*	X	X	—
Threespine stickleback	*Gasterosteus aculeatus*	X	X	X
Topsmelt	*Atherinops affinis*	—	—	X
Tule perch	*Hysterocarpus traski*	X	X	—
White sturgeon	*Acipenser transmontanus*	X	—	—
Introduced Species				
American shad	*Alosa sapidissima*	X	—	—
Black crappie	*Pomoxis nigromaculatus*	X	—	—
Bluegill	*Lepomis macrochirus*	X	X	—
Carp	*Cyprinus carpio*	X	—	—
Chameleon goby	*Tridentiger trigonocephalus*	—	X	—
Channel catfish	*Ictalurus punctatus*	X	—	—
Golden shiner	*Notemigonus crysoleucas*	X	—	—

Table 3-6. Fish species collected in the Napa River, Sonoma Creek, and Tolay Creek Watersheds.

Common Name	Scientific Name	Napa River	Sonoma Creek	Tolay Creek
Goldfish	*Carassius auratus*	X	—	—
Green sunfish	*Lepomis cyanellus*	X	—	—
Inland silverside	*Menidia beryllina*	X	—	X
Largemouth bass	*Micropterus salmoides*	X	—	—
Mosquitofish	*Gambusia affinis*	X	X	X
Rainwater killifish	*Lucania parva*	X	—	X
Shimofuri goby	*Tridentiger bifasciatus*	X	—	—
Smallmouth bass	*Micopterus dolomieui*	X	—	—
Striped bass	*Morone saxatilis*	X	X	X
Threadfin shad	*Dorosoma petenense*	X	—	—
Wakasagi	*Hypomesus nipponensis*	X	—	—
White catfish	*Ameiurus catus*	X	—	—
White crappie	*Pomoxis annularis*	X	—	—
Yellowfin goby	*Acanthogobius flavimanus*	X	X	X

Tolay Creek

Tolay Creek is a smaller stream system than either Sonoma Creek or the Napa River. It flows through the NSMWA prior to entering the San Pablo Bay to the west of Sonoma Creek. Many of the species found in Sonoma Creek, as well as in San Pablo Bay and the interior sloughs and ponds would be expected to occur in Tolay Creek.

During fish surveys in lower Tolay Creek conducted between 1999 and 2002, 13 fish species were collected, consisting of 8 native and 5 non-native species (Takekawa et al. 2000). These results are provided in **Table 3-6**.

Huichica Creek

Huichica Creek flows in a generally southern direction for approximately 8 miles before entering Hudeman Slough. Hudeman Slough flows through the Napa Slough into the Napa River. Steelhead and rainbow trout are currently found within Huichica Creek, and it is known to have supported a historical run of steelhead (Rich 2007). The lower reaches of Huichica Creek (below SR 121) are considered to have low habitat values for steelhead but serve as a migration corridor to more suitable upstream habitat (Leidy et al. 2005). A 10- to 12-foot-high culvert at the SR 121 crossing is considered to be a barrier to upstream migration. A waterfall approximately 1.75 miles upstream of SR 121 has been identified as a barrier to migration; however, the waterfall

may not actually be a barrier at all or may only be a partial barrier (Rich 2007). Fish population data are lacking for Huichica Creek, though several surveys found steelhead within the portion of the creek below the falls. The lower portions of Huichica Creek and Hudeman Slough can be expected to contain many of the fish found in the lower reaches of other streams within the NSMWA (e.g., mosquitofish, striped bass, yellowfin goby).

American Canyon Creek

American Canyon Creek drains the area immediately north of the City of Vallejo and enters the Napa River tidal slough. No anadromous fish have been found in American Canyon Creek during numerous surveys (Rich 2007; Leidy et al. 2005). Fish expected to occur in American Canyon Creek include common species found within intermittent, low-level streams in this area (e.g., threespine stickleback, mosquitofish).

3.8.3.2 Invertebrates

Aquatic invertebrates, including insects, amphipods, copepods, cladocera, marine (polychaetes) and freshwater worms (oligochaetes) and small mollusks are a primary food source for fish, including striped bass, delta smelt, and catfish, as well as waterfowl, including redhead, bufflehead, scaup, and canvasback ducks (CDFG 1977). A variety of benthic and pelagic invertebrates occur within the NSMWA.

Recent surveys of benthic invertebrates within the Napa River Unit documented 50 taxonomic groups represented by nematodes, polychaetes, bivalves, crustaceans, insects, and other various groups (Miles et al. 2004). Other surveys of invertebrates in the greater Napa-Sonoma Marshes include the Napa Sanitation District study on the effects of effluent on the benthic and invertebrate fauna of the Napa Marsh area (Gustafson and Carter 1976). This study documented polychaete worms, copepods, amphipods and opossum shrimps, bentnose and soft-shell crabs. The results of this study showed that the benthic biota of the Napa River is a continually changing one, primarily because of seasonal changes in salinity (CDFG 1977).

The opossum shrimp (*Neomysis mercedis*) is a primary food source of juvenile striped bass. During their early growth striped bass feed on the opossum shrimp. By mid-summer, the bass have grown to a size that fish become their primary food source. This seasonal diet change of the striped bass coincides closely with the July–August peak in the opossum shrimp population and the December–February decline (CDFG 1977).

Several of the former salt ponds in the NSMWA contain salinity levels that support brine shrimp (*Artemia franciscana*) and brine flies (*Ephydra millbrae*), important food sources for some species of water birds, such as American avocets and black-necked stilts and phalaropes (*Phalaropus* sp.).

San Francisco Bay supports the largest Dungeness crab (*Cancer magister*) nursery in the world, but it is illegal to harvest Dungeness crab in the bay (CDFG 1999 in Jones and Stokes 2004a).

Larval crabs are carried by currents into San Pablo and Suisun Bays, becoming widely distributed by July (CDFG 2008). By the spring of the following year, most of these crabs have returned to the ocean. A recent study conducted by DFG showed that crabs reared within San Francisco Bay grew approximately twice the rate of ocean-reared crabs (CDFG 2008).

A significant decrease in benthic invertebrate fauna in San Francisco Bay has been documented over the last several decades (URS 2001 in Jones and Stokes 2004a). The introduction of invasive nonnative species that compete with or feed on the native invertebrates, as well as habitat loss, has led to this decline. It is estimated that 40 to 100% of the benthic invertebrate fauna in any area of the bay are nonnative species (Carlton 1979; URS 2001). Asian clam (*Potamocorbula amurensis*), Chinese mitten crab (*Eriocheir sinenise*), and green crab (*Carcinus maenas*) are some of the invasive nonnative species of particular concern that have become well established in the bay (Jones and Stokes 2004a).

3.8.4 Special-status Plants

Several special-status plant species have been observed or are expected to occur within the NSMWA. **Figure 11** shows the location of known special status plant species occurrences in and around the NSMWA. Special-status plant species addressed in this section include:

- Species listed as threatened, endangered or rare under the state or federal Endangered Species Acts
- Species listed as species of special concern by the DFG
- Species listed as rare by the California Native Plant Society (CNPS)

Twelve special-status plants occur or have the potential to occur in the NSMWA**.** These species are summarized in **Table 3-7** and discussed in detail below.

San Joaquin Spearscale

San Joaquin spearscale (*Atriplex joaquiniana*), a CNPS List 1B.2 species, is an annul herb in the Goosefoot family (Chenopodiaceae). It occurs in meadows and seeps, playas and grasslands (alkaline). It was recorded in the American Canyon Unit in alkaline seasonal wetlands (CDFG 2008). It was also recorded in American Canyon Unit in seasonal alkaline wetlands; however, this location is now underwater. Suitable habitat for this species is present throughout the NSMWA.

Alkali Milk Vetch

Alkali milk vetch (*Astragalus tener* var. *tener*), a CNPS List 1B.2 species, is an annual herb in the goosefoot family. Its preferred habitat includes alkali flats and moist grasslands. An occurrence was recorded in 1993 on the north side of American Canyon Creek near the end of

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Napa Sonoma Marshes Wildlife Area Land Management Plan

FIGURE 11

Special-Status Occurrences: Plant Species

dwarf downingia
Delta tule pea
pappose tarplant
saline clover
dwarf downingia
Delta tule pea
soft bird's-beak
Delta tule pea
two-fork clover
Suisun Marsh aster
Marin knotweed
Delta tule pea
Delta tule pea
soft bird's-beak
Mason's lilaeopsis
Delta tule pea
Delta tule pea
Delta tule pea
legenere
Contra Costa goldfields
dwarf downingia
Delta tule pea
Suisun Marsh aster
Delta tule pea
soft bird's-beak
Delta tule pea
Marin knotweed
two-fork clover
Flat-faced downingia
Delta tule pea
soft bird's-beak
Marin knotweed
San Joaquin spearscale
alkali milk-vetch
Flat-faced downingia
San Joaquin spearscale
Mason's lilaeopsis

NSMWA Management Unit boundary

Base imagery: Airphoto USA, 1 April 2007, 0.3-meter cell size

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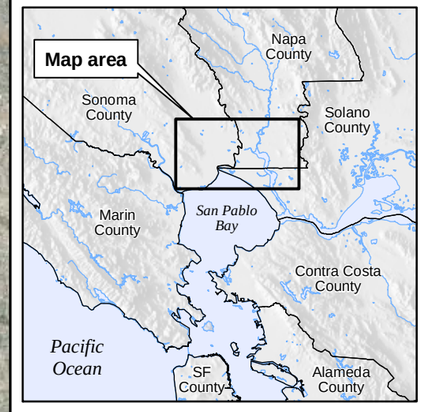

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Table 3-7. Special-status plant species occurring or with potential to occur in the NSMWA.

Scientific Name **Common Name**	**Federal[1]**	**State[2]**	**CNPS[3]**	**Preferred habitat**	**Potential to occur in the project area**
Atriplex joaquiniana San Joaquin Spearscale	—	—	1B.2	Alkali grassland, alkali scrub, alkali meadows, saltbush scrub, 1–320 m. Occurs with salt grass and alkali heath above pickleweed habitat. Blooms April–October.	**Present.** Occurrence recorded within the NSMWA on the north bank of American Canyon Creek. However, record is incomplete and location needs verification.
Astragalus tener var. *tener* Alkali Milk Vetch	—	—	1B.2	Playas, valley and foothill grasslands (adobe clay), alkaline vernal pools, 1-60 m. Blooms March-June	**Present.** Recorded along American Canyon Creek in the American Canyon Unit of the NSMWA.
Centromadia parryi ssp. *parryi* Pappose Tarplant	—	—	1B.2	Chaparral, coastal prairie, meadows and seeps, coastal salt marshes and swamps, valley and foothill grasslands (vernally mesic, often alkaline), 2-420 m. Blooms May-November.	**High.** Recorded near SR 121 in the vicinity of the NSMWA.
Cordylanthus mollis spp. *moll* Soft Bird's-Beak	FE	Rare	1B.2	Tidal salt marsh, 0–3 m. An annual, hemiparasitic herb that with fluctuating population levels. Occurs in upper tidal marsh near the limits of tidal action with pickleweed, salt grass, fleshy jaumea (*Jaumea carnosa*), alkali heath, perennial ryegrass (*Lolium perenne)*, arrow grass (*Triglochin* sp.), and Suisun marsh aster. Blooms July–November.	**High.** A population on degraded, marginal habitat on the south levee at the confluence of Dutchman and South Sloughs near Pond 3 had 50 individuals in 1982, but was not seen in 3 subsequent searches. This population may be extirpated. A population at Bentley Wharf 0.25 mile west of Pond 7A is considered extirpated. A 3-acre population occurs on Fagan Slough on the Napa River 2 miles northeast of Pond 8. Regular surveys by DWR at the Napa River Unit have not identified new populations (Jones and Stokes 2003a).
Downingia pusilla Dwarf Downingia	—	—	2.2	Valley and foothill grasslands (mesic), vernal pools, 1-455 m. Blooms March-May.	**Moderate.** Two non-specific occurrences are recorded in the vicinity of the Wingo and Ringstrom Bay Units of the NSMWA, as well as in association with a vernal pool on east side of the Napa River.
Lathyrus jepsonii var. *jepsonii* Delta Tule Pea	—	—	1B.2	Coastal and estuarine marshes, 0–4 m. Occurs with salt grass, pickleweed, arrow grass, bulrush, fleshy jaumea, Suisun marsh aster, and soft bird's-beak. Blooms May–September.	**Present.** Several populations are reported in the NSMWA and vicinity including South Slough, and along the Napa River at Coon Island and Pond 8, along Fagan Slough and in the Huichica Creek Unit.

Table 3-7. Special-status plant species occurring or with potential to occur in the NSMWA.

Scientific Name **Common Name**	**Federal[1]**	**State[2]**	**CNPS[3]**	**Preferred habitat**	**Potential to occur in the project area**
Legenere limosa Legenere	—	—	1B.1	Freshwater marshes and vernal pools, 1-880 m. Blooms April-June.	**Low.** No occurrences in the NSMWA. Closest occurrence 1 mile east of Southern Crossing Unit in association with vernal pool. Species may occur in freshwater ponds of the NSMWA. However, ponds in the NSMWA are likely brackish due to slightly saline groundwater and saline soils.
Mason's Lilaeopsis	—	Rare	1B.1	Freshwater and brackish intertidal marshes, streambanks in riparian scrub, silty areas generally at mean sea level. Occurs with arrow grass, fleshy jaumea, brass buttons, and pickleweed. Blooms April–November.	**Present.** Populations are reported from the banks of the Napa River in the Southern Crossing Unit and Green Island Unit.
Polygonum marinense Marin Knotweed	—	—	3.1	Coastal salt marsh and higher elevation coastal brackish marsh, 0–10 m. Occurs with pickleweed, salt grass, and gum plant. Blooms April–October.	**High**. Three populations are reported from the project vicinity, including Fagan Marsh about 2 miles northeast of Pond 8, and about 1 mile east of Pond 3 across the Napa River.
Symphyotrichum lentus Suisun Marsh Aster	—	—	1B.2	Brackish and freshwater marsh, silty areas, 0–3 meters [m]. Occurs with pickleweed, arrow grass, salt bush, bulrush, soft bird's beak, and Delta tule pea. Blooms May– November.	**High.** Several populations recorded at Fagan Marsh Ecological Reserve on the Napa River.
Trifolium amoenum Showy Indian Clover	FE	—	1B.1	Coastal bluff scrub, valley and foothill grasslands, 5–415 m. Blooms April–June.	**Low**. Old occurrence recorded in vicinity of NSMWA; however, species was not relocated in subsequent surveys.
Trifolium depauperatum var. *hydrophilum* Saline Clover	—	—	1B.2	Marshes and swamps, valley and foothill grasslands, vernal pools. Alkaline, mesic sites.	**Moderate**. Recorded adjacent to the Wingo Unit of the NSMWA in the Viansa Wetlands.

Table 3-7. Special-status plant species occurring or with potential to occur in the NSMWA.

[1] United States Fish and Wildlife Service classifications:

FE = Federally Endangered. Species in danger of extinction throughout all or significant portion of its range.

FT = Federally Threatened. Species likely to become endangered within foreseeable future throughout all or significant.

[2] California Department of Fish and Game classifications:

CE = State endangered. Species who's continued existence in California is jeopardized.

CT = State threatened. Species, although not presently threatened with extinction, may become endangered in the foreseeable future.

CR = State listed as rare. Plant species, although not presently threatened with extinction, may become endangered in the foreseeable future.

CP = Fully protected by the State of California under Sections 3511 and 4700 of the Fish and Game Code.

[3] California Native Plant Society classifications:

List 1A = Plants that are presumed extinct in California.

List 1B = Plants that are Rare, Threatened, or Endangered in California and elsewhere.

List 2 = Plants that are Rare, Threatened or Endangered in California but more common elsewhere.

List 3 = Plants for which more information is needed.

List 4 = Plants of limited distribution.

.1 = Seriously endangered in California

.2 = Fairly endangered in California

.3 = Not very endangered in California

Mini Drive in the NSMWA (CDFG 2008). Suitable habitat for this species occurs throughout the NSMWA.

Pappose Tarplant

Pappose tarplant (*Centromadia parryi* ssp. *parryi*), a CNPS List 1B.2 species, is an annual herb in the aster family (Asteraceae). It occurs in coastal prairies, chaparral, meadows and seeps, coastal salt marshes and vernally mesic (often alkaline) grasslands. The only recorded occurrence in the vicinity of the NSMWA exists at an unspecific location along SR 121 (CDFG 2008). Suitable habitat for this species is present in moist grasslands of the NSMWA.

Soft Bird's Beak

Soft bird's beak (*Cordylanthus mollis* spp. *mollis*) is a federally endangered, state listed rare and CNPS List 1B.2 species. It is as annual herb in the snapdragon family (Scophulariaceae). It is found along the upper reaches of tidally influenced saltgrass pickleweed marshes at or near the limits of tidal action (USFWS 1997). Two historic locations in the Napa-Sonoma Marshes are considered extirpated due to habitat loss/conversion (occurrences at Bentley Wharf and Mare Island). An occurrence at Fagan Marsh Ecological Reserve, adjacent to the NSMWA is considered extant. Suitable habitat for this species is present in the upland tidal marshes of the Napa River, Huichica Creek, America Canyon, and Tolay Creek units.

Dwarf Downingia

Dwarf downingia (*Downingia pusilla*), a CNPD List 2.2 species, is a small annual herb in the bellflower family (Campanulaceae). It occurs in vernal pools as well as mesic sites in grasslands and along streams. There are three recorded occurrences of this species in the vicinity of the NSMWA. Two of the occurrences recorded near Ringstrom Bay and Wingo are unspecific and need verification. Another is recorded in association with vernal pools on the east side of the Napa River (CDFG 2008). Suitable habitat for this species is present in mesic, non-saline mesic grasslands and freshwater creeks and wetlands in all Management Units of the NSMWA.

Delta Tule Pea

Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), a CNPS List 1B.2 species, is an annual herb in the pea family (Fabaceae). It occurs in freshwater and brackish freshwater marshes. Occurrences are known from Pond 8, Coon Island, Ringstrom Bay, Huichica Creek, Southern Crossing, and nearby the NSMWA in Cullinan Ranch and Fagan Marsh Ecological Preserve (CDFG 2008). Suitable habitat is present in all Management Units of the NSMWA.

Delta tule pea (photo by Mark Foigel)

Flat-faced Downingia

Flat-faced Downingia is a locally rare, but not formally listed annual species known to occur at the Tolay Creek Unit (north) and historically in the White Slough Unit of the NSMWA (Demgen 2008). This species was once widespread along tidal marsh edges in the San Francisco Bay (Baye 2008), as well as vernal pools. However, loss of habitat is virtually extirpated this species from this habitat. At White Slough, this species occurs in low numbers in association with a created seasonal wetland. At Tolay Creek, flat-faced downingia occurs in dense patches in the historic floodplain of Tolay Creek, in bare areas among pickleweed and spike rush.

Flat-faced downingia (*Downingia pulchella*) at the Tolay Creek Unit (photo by: Dina Robertson, URS)

Legenere

Legenere (*Legenere limosa)* is a small, nondescript annual herb in the bellflower family. Legenere is a CNPS List 1B.1 species. It is found in freshwater wetlands and vernal pools. The nearest recorded occurrence of this species to the NSMWA is on the east side of the Napa river at Suscol Ridge. Suitable habitat is limited to absent in the NSMWA; this species is possible, but unlikely to occur at restored freshwater ponds in the NSMWA.

Mason's Lilaeopsis

Mason's lilaeopsis, a CNPS List 1B.1 species, is a small herb in the aster family. This species is found in freshwater and brackish marshes in the low marsh zone, often along eroding shores and earthen levees. There s a known occurrence of this species within the Southern Crossing and Green Island Units in the NSMWA along the Napa River (CDFG 2008). Suitable habitat is present in all Management Units of the NSMWA.

Marin Knotweed

Marin knotweed (*Polygonum marinense*), a CNPS List 3.1 species, is an annual herb in the knotweed family (Polygoneaceae). It occurs in coastal salt and brackish marshes. It is recorded

in the pickleweed salt marshes of Fagan Marsh, as well as at non-specific location in the vicinity of Southern Crossing Unit. It was also recorded in 1995 in the White Slough Unit (CDFG 2008). Suitable habitat is present in all Management Units of the NSMWA.

Suisun Marsh Aster

The Suisun marsh aster (*Symphyotrichum lentus*), a CNPS List 1B.2 species, is a perennial herb in the aster family. It is found along sloughs of brackish and freshwater marshes. An occurrence is recorded near NSMWA at Fagan Marsh Ecological Reserve (CDFG 2008). Suitable habitat for this species occurs throughout the NSMWA.

Showy Indian Clover

Showy Indian clover (*Trifolium amoenum*) is a federally endangered and CNPS List 1B.1 species. It is an annual herb in the pea family. It occurs in valley and foothill grasslands and coastal bluff scrub. Many of the recorded occurrences in California have been lost to development, and very few known occurrences therefore remain. This species was recorded in the vicinity of Buchli Station Road in 1952, and the species was not relocated during subsequent surveys in 1987. Suitable habitat is present in grasslands in the NSMWA.

Saline Clover

Saline clover (*Trifolium depauperatum* var. *hydrophilum*), a CNPS List 1B.2 species, is an annual herb in the pea family. It is found in low lying, poorly drained alkaline soils in valley and foothill grasslands. It was recorded in 1996 adjacent to Wingo Unit in the Viansa Wetlands, a former hayfield that was restored to wetlands in 1992 (CDFG 2008). It is also known from Sears Point (owned by Solano Land Trust) (Baye 2008.) It is very likely this species occurs in the NSMWA, specifically in association with flat-faced Downingia at the Tolay Creek Unit (north).

3.8.5 Special-status Wildlife

Several special-status wildlife species have been observed or are expected to occur within the NSMWA. Special-status wildlife species addressed in this section include:

- Species listed as threatened, endangered, or rare under the state or federal Endangered Species Acts
- Species listed as species of special concern by the DFG
- Fully Protected Species under the California Fish and Game Code

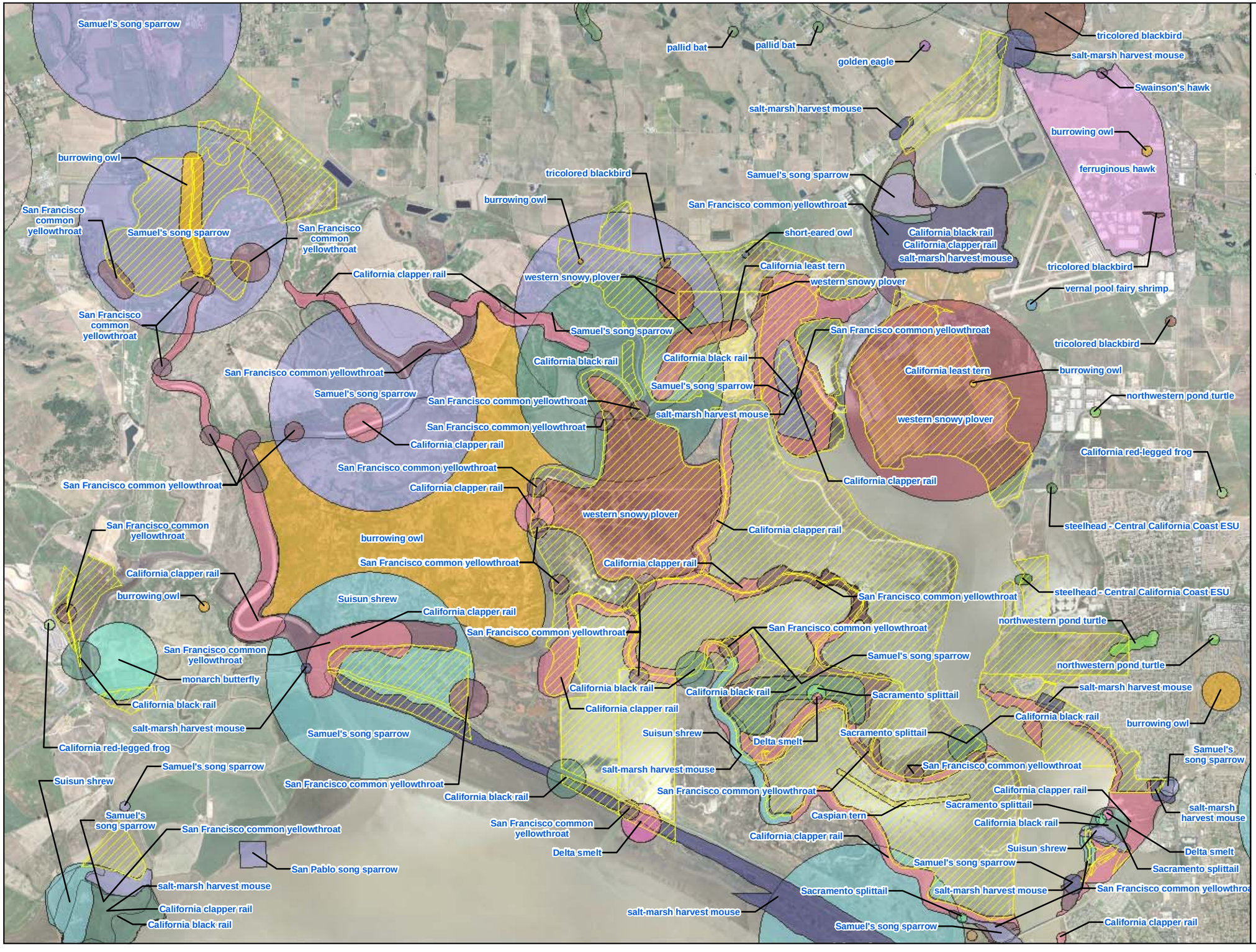
Species that occur or have potential to occur in the NSMWA are summarized in **Table 3-8** and discussed in detail below.

Figure 12 shows the location of special-status wildlife, fisheries, and invertebrate species recorded in and adjacent to the NSMWA.

Napa Sonoma Marshes Wildlife Area Land Management Plan

FIGURE 12

Special-Status Occurrences: Wildlife, Fisheries, and Invertebrate Species



NSMWA Management Unit boundary

Base imagery: Airphoto USA, 1 April 2007, 0.3-meter cell size

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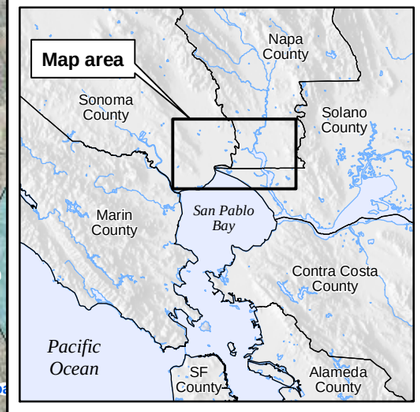

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Table 3-8. Special-status wildlife species with potential to occur in the NSMWA.

Scientific Name Common name	Federal[1]	State[2]	Preferred Habitat	Potential to Occur in the Project Area
Amphibians				
Rana aurora draytonii California red-legged frog	FT	SC	Permanent and semi-permanent aquatic habitats, such as creeks and coldwater ponds, with emergent and submergent vegetation and riparian species along the edges; may aestivate in rodent burrows or cracks during dry periods.	**Moderate.** The brackish and saline waters of the NSMWA are generally unsuitable for this species. Potential habitat along Huichica, American Canyon and Tolay Creek (north of SR 37).
Birds				
Agelaius tricolor Tricolored Blackbird	—	SC	Nests in dense colonies in emergent marsh vegetation, such as tules and cattails, or upland; probably requires water at or near the nesting colony; requires large foraging areas, including marshes, pastures, agricultural wetlands, dairies, and feedlots, where insect prey is abundant.	**Present.** Recorded nesting colony in upland pond of the Huichica Creek Unit. Potential habitat in American Canyon Unit freshwater pond surrounded by tall emergent marsh.
Asio flammeus Short-eared Owl	—	SC	Freshwater and salt marshes, lowland meadows, and irrigated alfalfa fields; needs dense tules or tall grass for nesting and daytime roosts.	**Moderate.** Suitable foraging and breeding habitat present. Observed at pond along Buchli Station Rd. in the Huichica Creek Unit.
Aquila chrysaetos Golden Eagle	FD	FP	Typically frequents rolling foothills, mountain areas, sage-juniper flats, and desert. Breeds on cliffs or in large trees or electrical towers, forages in open areas.	**Present**. No recorded breeding occurrences in the NSMWA, however, this species has been observed foraging on several occasions in the NSMWA at Huichica Creek Unit around Huichica Creek. Extensive foraging and some nesting habitat present in and around NSMWA.
Athene cunicularia hypugea Western Burrowing Owl	—	SC	Level, open, dry, heavily grazed, or low-stature grassland or desert vegetation with available burrows.	**Moderate.** Species observed in the Huichica Creek, Green Island, and Wingo units (incidental, non-breeding) of the NSWMA.
Buteo swainsoni Swainson's Hawk	—	CT	Breeds in stands with few trees in juniper-sage flats, riparian areas, and oak savannah; forages in adjacent livestock pasture, grassland, or grain fields.	**Medium**. Known nesting occurrence in vicinity of the NSMWA. Suitable nesting and foraging habitat in the NSMWA
Charadrius alexandrinus nivosus Western Snowy Plover	FT	SC	Coastal beaches above the normal high-tide limit in flat, open areas with sandy or saline substrates; vegetation and driftwood are usually sparse or absent.	**Present.** Known to breed and forage in the Huichica Creek Unit and the Green Island Unit.
Circus cyaneus Northern Harrier	—	SC	Grasslands, meadows, marshes, and seasonal and agricultural wetlands providing tall cover.	**Present**. Known to breed and forage in the NSMWA.
Elanus leucurus White-tailed Kite	—	FP	Low foothills or valley areas with valley (*Quercus lobata*) or live oaks (*Quercus agrifolia* and *Q. wislizenii*), riparian areas, and marshes near open grasslands for foraging.	**Present.** Known recent and historic occurrences in association with former salt ponds, American Canyon Creek and other habitats in the NSMWA.

Table 3-8. Special-status wildlife species with potential to occur in the NSMWA.

Scientific Name **Common name**	**Federal[1]**	**State[2]**	**Preferred Habitat**	**Potential to Occur in the Project Area**
Falco peregrinus Peregrine Falcon	FD	SE, FP	Breeds in woodland, forest, and coastal habitats; requires a scrape or depression on ledges and cliffs to nest, or occasionally tree or snag cavities. Hunts ducks, mammals, insects and fish.	**Present.** This species observed (fly over) in 2007-2008 over the Napa River Unit, as well as perching on electrical towers in the Tolay Creek Unit (lower) in 2006. Presumably falcons use the towers as a vantage point to hunt pheasant.
Geothlypis trichas sinuosa San Francisco Common Yellow Throat	—	SC	Breeds in woody swamps, brackish marshes and freshwater marsh; requires tall grasses, tules, and willow thickets for nesting and cover.	**Present**. This species is recorded at several locations in and around the NSMWA.
Laterallus jamaicensis obsoletus California Clapper Rail	FE	SE, FP	Restricted to salt marshes and tidal sloughs; usually associated with heavy growth of pickleweed; feeds on mollusks removed from the mud in sloughs.	**Present**. This species is recorded at several locations in and around the NSMWA.
Laterallus jamaicensis coturniculus Black Rail	—	FP, ST	Tidal salt marshes associated with heavy growth of pickleweed; also occurs in brackish marshes or freshwater marshes at low elevations.	**Present**. This species is recorded at several locations in and around the NSMWA.
Melospiza melodia samuelis Samuel's Song Sparrow	—	SC	Uses tidal sloughs in pickleweed marshes; requires tall bushes (usually grindelia) along sloughs for cover, nesting, and song-posts; forages over mud banks and in the pickleweed.	**Present**. This species is recorded at several locations in and around the NSMWA.
Pelecanus erythrorhynchos American White Pelican	—	—	The American white pelican is a piscivore that frequents shallow water. It nests exclusively on islands within large saline lakes in Western North America.	**High**. This species is a common visitor to the NSMWA, but this species does not breed in the NSMWA.
Sternula antillarum brown California Least Tern	FE	SE	Nests in open areas on coastal beaches and estuaries near shallow water, usually on sand or fine gravel. Successful breeding birds observed in 2008 in the NSMWA.	**Present.** Species observed breeding in the Green Island Unit in 2008.
Mammals				
Antrozous pallidus Pallid Bat	—	SC	Occurs in a variety of habitats from desert to coniferous forest. Most closely associated with oak (*Quercus* sp.), yellow pine, redwood, and giant sequoia habitats in northern California and oak woodland, grassland, and desert scrub in southern California. Relies heavily on trees for roosts, but also nests in structures such as barns and bridges.	**High.** Many known occurrences in the vicinity of the NSMWA. One historic location at Huichica Creek.
Sorex ornatus sinuosus Suisun Shrew	—	SC	Tidal, salt, and brackish marshes containing pickleweed, grindelia, bulrushes, or cattails; requires driftwood or other objects for nesting cover.	**Present**. Species was trapped at several locations in and around the NSMWA.

Table 3-8. Special-status wildlife species with potential to occur in the NSMWA.

Scientific Name **Common name**	**Federal[1]**	**State[2]**	**Preferred Habitat**	**Potential to Occur in the Project Area**
Reithrodontomys raviventris Salt Marsh Harvest Mouse	FE	SE	Utilizes both pickleweed dominated and mixed-halophyte dominated vegetation of diked and tidal wetland systems; uplands used to a lesser extent.	**Present.** Several known occurrences in and adjacent to the NSMWA.
Reptiles				
Clemmys marmorata marmorata Western Pond Turtle	—	SC	Woodlands, grasslands, and open forests; occupies ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and with watercress, cattails, water lilies, or other aquatic vegetation.	**Present.** Known to occur in the NSMWA along American Canyon Creek and Huichica Creek in the NSMWA.

[1] United States Fish and Wildlife Service classifications:

FE = Federally Endangered. Species in danger of extinction throughout all or significant portion of it's range.

FT = Federally Threatened. Species likely to become endangered within foreseeable future throughout all or significant

FD = Federally Delisted.

[2] California Department of Fish and Game classifications:

SE = State endangered. Species who's continued existence in California is jeopardized.

ST = State threatened. Species, although not presently threatened with extinction, may become endangered in the foreseeable future.

SC = California species of special concern. Animal species with California breeding populations that may face extinction in the near future.

FP = Fully protected by the State of California under Sections 3511 and 4700 of the Fish and Game Code.

3.8.5.1 Special-Status Amphibians

California Red-legged Frog

California red-legged frog (CRLF) (*Rana aurora draytonii*) is a federally threatened and state species of concern. It inhabits freshwater pools and streams, marshes, and occasionally ponds. CRLF deposits eggs in permanent pools attached to freshwater vegetation.

This species was recorded at two locations in 1998 in the immediate vicinity of the NSMWA on lands owned by the Brenda Raceway Corporation along SR 121, across from the Tolay Creek Unit (CDFG 2008). Habitat at those locations consists of stock ponds with emergent vegetation. This species was also recorded in a tributary to American Canyon Creek in 2007 (CDFG 2008). Suitable habitat for this species is present along Sonoma Creek (upper), Tolay Creek (upper), Huichica Creek, and American Canyon Creek in the NSMWA. Upland ponds and marshes of the NSMWA are typically too saline for this species (Wyckoff 2007); however, adult CRLF can handle fairly saline water. Dispersing adults and sub-adults have been found in salinities of up to 36 parts per thousand. CRLF are less likely to breed in these locations because eggs and larval stages are much more sensitive to salinity.

3.8.5.2 Special-status Birds

Tricolored Blackbird

The tricolored blackbird (*Agelaius tricolor*) is a state species of special concern. This species breeds in freshwater, preferably in emergent vegetation with tall, dense cattails and tule, but also thickets of willow, blackberry, wild rose, and tall herbs (CDFG 2005). It is also known to feed is grasslands and croplands, flooded lands and edges of ponds. It is a colonial nester and yearlong resident in California. Approximately 200+ adults were observed nesting in 1992 and 1993 in a created pond at Huichica Creek Unit in uplands. Several other breeding colonies are known from the vicinity of the NSMWA (CDFG 2007a).

Short-Eared Owl

Short-eared owl (*Asio flammeus*) is a state species of concern. This species usually occurs in open areas with few trees, such as grasslands, dunes, meadows, saline and fresh emergent wetlands (CDFG 2005). It feeds primarily on voles and other small mammals, reptiles and amphibians. It nests in dense vegetation on dry ground in a depression lined with sticks, feathers, grasses, etc. This species was observed in association with a created pond near Buchli Station Road in the NSMWA (Wyckoff 2008). Suitable breeding and foraging habitat exists in the grasslands of the NSMWA.

Golden Eagle

Golden eagle is a state fully protected species. This species foraged over open terrain of grasslands, deserts, savannahs, and shrub habitats. Prey includes small mammals, fish, reptiles

and amphibians. Golden eagles nest in secluded overhanging ledges and large trees (CDFG 2007a). No breeding occurrences of this species have been recorded in the NSMWA or vicinity. The nearest breeding occurrence is north of the project area along the Napa River (CDFG 2008). Suitable foraging habitat exists throughout the NSMWA. Golden eagles have been observed by DFG staff foraging in the Marshes. Limited nesting habitat exists in large trees in the NSMWA, such as Eucalyptus trees along the levees of the Marshes.

Western Burrowing Owl

The western burrowing owl (*Athene cunicularia hypugea)* is a state species of special concern. "Huichica" is the Wappo Indian name for the burrowing owl, which was once abundant in the Huichica Creek Area. Burrowing owls inhabit flat, dry, open grasslands in prairie and arid habitats throughout California, exclusive of the humid, northwest coastal areas and the forested and shrub-covered mountains. These owls can be found adjacent to the San Francisco Bay on levees next to salt ponds, open unmanicured grasslands, or manicured fields near the Bay's edge where ground squirrel numbers and foraging area are adequate. These birds are primarily terrestrial predators and in these locations still focus on mice and insects. However, they are opportunistic and will eat species associated with wetlands, including amphibians and crustaceans (Goals Project 2000.). Burrowing owls were observed nesting in 1988 at Upper Tubbs Island and Skaggs Island, as well as on private lands at Sears Point in 2003 (CDFG 2008). A wintering site was recorded in 2006 within the city of American Canyon on the side of Devlin Road (CDFG 2008). This species was also observed in 2001 at the "burn unit" of the Huichica Creek Unit and perching on the Union Pacific Railroad tracks in the Wingo Unit (Wyckoff 2008). This species was also observed in the Green Island Unit in 2009. Several surveys of the owls at the Green Island Unit were conducted in 2009; however, no nesting was observed (Taylor 2009).

Burrowing owl at the Green Island Unit (photo by: Karen Taylor, DFG)

Swainson's Hawk

Swainson's hawk is a state threatened species. In California, breeding populations of Swainson's hawks occur in desert, shrubsteppe, grassland, and agricultural habitats, however, the overwhelming majority of the state's breeding sites are in two disjunct populations in the Great Basin and Central Valley (PRBO 2007). It roosts in large trees, however, these hawks will nest on the ground of no trees are available (CDFG 2005). Prey includes mice, gophers, rabbits,

arthropods, reptiles, birds, and rarely, fish (CDFG 2005). Swainson's hawk typically use grasslands and agricultural fields for hunting.

There is a recorded breeding Swainson's hawk from 2005 in close proximity to the NSMWA. This occurrence is along Suscol Creek less than a mile east of the Southern Crossing unit of the NSWMA (CDFG 2008). It is likely that this species forages in the grasslands and upper tidal marshes of the NSMWA. Suitable nesting habitat is also present in the NSMWA.

Western Snowy Plover

The western snowy plover is a federally threatened and state species of special concern. Dry salt ponds and unvegetated salt pond levees are used as plover nesting habitat. Salt ponds with shallow water provide important foraging habitat for plovers. Nesting plovers can be attracted to an area when ponds are drained during the breeding season, but flooding can then destroy the nests when the ponds are refilled (USFWS 2001). Breeding snowy plovers were recorded at Little Island Farms of the Napa River Unit in 1990, on small islands within the Huichica Creek Unit in 2002, and on levees of Fly Bay (Huichica Creek Unit) in 1992 (CDFG 2008). Snowy plovers were observed in the Napa River Unit in April of 2002 at Pond 7 (Jones and Stokes 2003a) and at the Green Island Unit. More current observations of this species in the NSMWA include breeding pairs on the internal levee between Ponds 7 and 7A in 2008 and 2009 and sightings of individual plovers at the Green Island Unit in 2008 (Taylor 2008c).

Northern Harrier

Northern harrier is a state species of special concern. It winters in and forages over marshes and grassland. Harriers nest on the ground in shrubby vegetation usually at the marsh edge. Nests are composed of a mound of sticks in wet areas. It feeds on small mammals, birds, reptiles, fish and insects (CDFG 2005). Breeding northern harriers are known from the NSMWA at Coon Island, the northern White Slough Unit and Pond 2A (CDFG 2007a).

White-tailed Kite

White-tailed kite (*Elanus leucurus*) is a state fully protected species. The white-tailed kite forages over grasslands, meadows and farmlands. This species nests in trees near foraging grounds. The prey base of the white-tailed kite includes voles, and other small mammals, birds, insects, reptiles, and amphibians (CDFG 2005).Occupied nests were observed at Pond 8 in the NSMWA (Burner et al. 2003). Communal winter roots were observed on Knight Island in 1958 on dead Eucalyptus trees along the levee (45 birds) (Longhurst 1959).

San Francisco Common Yellow Throat

The San Francisco common yellowthroat (*Geothlypis trichas sinuosa*) (formerly known as saltmarsh common yellowthroat) is a state and federal species of concern. It is believed to be a resident of coastal salt marsh habitats from San Francisco Bay south to San Diego (Goals Project 2000). In the bay region, approximately 60% of San Francisco common yellowthroats breed in

brackish marsh, 20% in riparian woodland, 10% in freshwater marsh, 5% in salt marsh, and 5% in upland vegetation (Jones and Stokes 2003a). These birds are insectivorous, gleaning insects from low herbaceous vegetation, bushes, and small trees in the Marshes and from the surface of the mud along associated channels (Goals Project 2000). In the San Francisco Bay area, the San Francisco common yellowthroat winters in pickleweed marshes on the Skaggs Island complex and breeds in adjacent brackish marshes (Jones and Stokes 2003a). Surveys by Hobson et al. (1986) and Foster (1977a and 1977b) indicate that the Napa River Unit has some of the highest breeding densities of San Francisco common yellowthroats in the Bay Area (Jones and Stokes 2003a). The majority of the San Francisco common yellowthroat territories are in brackish marsh habitat. Territories included vegetation characterized by dense mixtures of salt-tolerant plants intermixed with freshwater plants. This species is known from several locations in and around the NSMWA (CDFG 2008).

California Clapper Rail

California clapper rail

The California clapper rail is both federally and state listed endangered. It occurs in marshes from Humboldt to San Luis Obispo Counties. In San Pablo Bay, they are a fairly new resident species. The suitability of the Napa-Sonoma Marshes has increased for this rail due to the reduction of freshwater input from the Sacramento-San Joaquin delta over time, causing the marsh to become more brackish (USFWS 1984). They occur within a wide range of brackish and salt water marshes, using a network of tidal sloughs as foraging and nesting habitat (USFWS 1984). The preferred habitat is comprised of tidal sloughs with a dominant cover of pickleweed and cordgrass (Burner et al. 2003). The California clapper rail was documented during recent surveys at Coon Island and White Slough in the NSMWA (Takekawa et al. 2005). These surveys were part of a larger, multi-year study of California clapper rails in the San Francisco Estuary. Survey results for California clapper rails in the San Pablo Bay show a great degree of variability, and more information is needed to determine if overall the population of clapper rails has changed (PRBO 2005). Historic and current occurrences are known from many locations in and around the NSMWA, including Coon Island Unit, Fly Bay of the Huichica Creek Unit, Napa River Unit, Tolay Creek Unit (north of SR 37) and White Slough Unit, and the Fagan Marsh Ecological Reserve (CDFG 2006b, 2008).

California Black Rail

The California black rail is a state listed threatened species. This species prefers pickleweed-dominated marsh habitat but also occurs in freshwater and brackish marshes (Jones and Stokes

2003a). Preferred breeding habitat includes areas of mature, higher-elevation marshes dominated by bulrush and pickleweed. California black rail occurs at a number of sites in the San Francisco Bay area, perhaps more concentrated in the northern part of the bay. The species will nest in higher areas of freshwater marshes, wet meadows, and salt marshes (Jones and Stokes 2003a). Surveys conducted in 1976 (Manolis 1978), 1988 (Evens et al. 1988), and 2005 (Takekawa et al. 2005) indicate that California black rails occur in the Napa River Unit. Indices of rail abundance (rails per census station) ranged from 0.11 in the area to the east of the intake channel along San Pablo Bay to 2.09 at the north mouth of South Slough. The area in and adjacent to the Napa River Unit has the highest relative density of black rails as well as the largest contiguous population in the San Francisco Bay area (Jones and Stokes 2004a, 2004b; Takekawa et al. 2005).

California black rail
(photo by: Isa Woo, USGS)

Samuel's Song Sparrow

Samuel's song sparrow (*Melospiza melodia samuelis*) (formerly know as San Pablo song sparrow) is a state species of concern that is restricted to the salt marshes of San Pablo Bay (Goals Project 2000). These birds generally inhabit regions of the salt marshes characterized by mixed pickleweed/cordgrass vegetation along channels and grindelia sub-shrub bushes that provide nesting sites and song perches (Goals Project 2000). Samuel's song sparrow is omnivorous, subsisting primarily on detritus feeding insects, other invertebrates from intertidal mud, the maturing heads of grindelia flowers, and the fleshy fruits and tiny seeds of pickleweed (Goals Project 2000). Records of occurrence for this species have been documented throughout the San Pablo Bay area, primarily in marsh vegetation along agricultural ditches and tidal channels (Goals Project 2000). There are several documented occurrences of this species in the NSMWA and immediate vicinity at Pond 2A, Coon Island Unit, White Slough Unit, Cullinan Ranch, Fagan Marsh Ecological Reserve, Tolay Creek, and in the vicinity of the Huichica Creek, Ringstrom and Wingo Units of the NSMWA.

American White Pelican

The American white pelican is a state species of special concern. It nests exclusively on islands within large saline lakes in Western North America. Occurrence in the San Francisco Bay Area are very localized and confined to the non-breeding season, generally from June through December (Goals Project 2000). The American white pelican is a piscivore that frequents shallow water and is seen (rarely) in the open parts of the Bay only in transit. They are almost exclusively gregarious and roost in flocks on dikes (Goals Project 2000). They feed in varying water depths, diving for its prey from the surface and scooping them up in pouch (CDFG 2005).

The American white pelican is frequently observed in the White Slough, Huichica Creek, and Napa River units of the NSMWA.

California Least Tern

USFWS listed the California least tern as endangered in 1970 due primarily to a loss of foraging habitat or coastal nesting habitat (USFWS 1985). It is a migratory bird that nests along the Pacific coast from southern Baja Mexico to the San Francisco Bay in lagoons, mouths of bays, and shallow estuaries. This bird is thought to winter in Latin America, but the winter range and habitat are largely unknown. Least terns typically arrive at California breeding areas in mid- to late-April and depart in August. They nest in colonies on bare or sparsely vegetated flat substrates near open water. Least tern nests are ground depressions called "scrapes" (Goals Project 2000), which they readily abandon when disturbed. This species can sometimes be found nesting in single pairs. These birds can be opportunistic nesters in such areas as newly graded or filled lands. Least terns forage over shallow to deep waters. They have been known to consume a wide variety of fish species, though they appear to prefer northern anchovy (*Engraulis mordax*) and silversides (*Atherinops* sp.) (Goals Project 2000).

California least tern chicks at the NSMWA (photo by: Karen Taylor, DFG)

DFG staff observed successful breeding of California least tern pairs in 2008 in the Green Island Unit of the NSMWA. In 2009, DFG staff observed numerous successful nests at the Green Island Unit and Ponds 7/7A of the Huichica Creek Unit (Taylor 2009). These observation are the most northern breeding occurrences on record.

3.8.5.3 Special-Status Mammals

Pallid Bat

Pallid bat (*Antrozous pallidus*) is a state species of special concern. This species occurs in grasslands, shrublands, deserts, woodlands, and forests. Pallid bat roosts in rocky habitat such as caves, crevices and mines, as well as in structures such as buildings and bridges (CDFG 2005). There are several recorded occurrences of this species in the vicinity of the NSMWA (CDFG 2008). These occurrences are of roosts associated with bridges and buildings. Suitable breeding and foraging habitat is present throughout the NSMWA.

Suisun Shrew

The Suisun shrew (*Sorex ornatus sinuosus*) is a state species of special concern. The current distribution of this shrew is limited to the scattered, isolated remnants of natural tidal salt and brackish marshes surrounding the northern borders of Suisun and San Pablo bays (Goals Project 2000). Suisun shrews typically inhabit saline and brackish tidal marshes characterized by Pacific cordgrass, pickleweed, gumplant, California bulrush, and common cattail (*Typha latifolia*). However, shrew occurrence appears to be more strongly associated with vegetation structure rather than species composition. Suisun shrews prefer dense, low-lying vegetation which provides protective cover and suitable nesting sites, as well as abundant invertebrate prey species (Goals Project 2000). It feeds on insects, slugs, snails, centipedes, and occasionally on amphibians. Driftwood, planks, and other debris found above the high-tide line also affords shrew with valuable foraging and nesting sites. In addition, adjacent upland habitats provide essential refuge areas for Suisun shrews and other terrestrial animals during periods of prolonged flooding (Goals Project 2000). This species was recently trapped at several locations in and around the NSMWA including South Slough and Dutchman Slough, White Slough and along Tolay Creek (CDFG 2008).

Salt Marsh Harvest Mouse

The salt marsh harvest mouse is listed both state and federally endangered. Salt marsh harvest mice are small, native rodents which are endemic to the salt marshes and adjacent diked wetlands of San Francisco Bay (Goals Project 2000). It is a federal and state listed endangered species. They are dependent on thick, perennial cover of salt marshes and move into adjacent grasslands only in the spring and summer when the grasslands provide maximum cover (Goals Project 2000). Historically, optimal vegetation composition for the mice was shown to include a high percentage of pickleweed (greater than 60 percent), with complexity in the form of fat hen and alkali heath or other halophytes (plants adapted to living in saline environment). In addition, the amount of saltgrass, brass buttons, alkali bulrush or other bulrush or cattail species should be low (USFWS 1984). However, recent studies have shown that mixed-halophyte and pickleweed dominated vegetation types support roughly equal salt marsh harvest mouse population densities, reproductive potential, and survivorship. In addition, dempograhic performance appears to be similar in both diked and tidal wetland systems (Sustaita et al. 2004). The salt marsh harvest mouse does not burrow, but rather build nests of loose balls of grasses on the surface of the ground, something that may be abandoned at the next high tide (USFWS 1984). This species has been trapped at several locations in and around the NSMWA including Fagan Marsh Ecological Reserve, Coon Island Unit and Fly Bay subunit, along South Slough and Dutchman Slough, at

Salt Marsh Harvest Mouse (photo by: Karen Taylor, DFG)

White Slough Unit, along Tolay Creek , on the west side of Sonoma Creek Bridge, and the south edge of Pond 1 (CDFG 2008).

3.8.5.4 Special-status Reptiles

Western Pond Turtle

The western pond turtle (*Clemmys marmorata marmorata*) is a state species of special concern. The pond turtle is most often associated with permanent ponds, lakes, streams and irrigation ditches. This species eats aquatic plant material including pond lilies, beetles and a variety of aquatic invertebrates as well as fishes and frogs (CDFG 2005). For reproduction, western pond turtle lays eggs on the ground in grasslands and riparian areas (CDFG 2005). One occurrence (three adults and one juvenile) of the western pond turtle was recorded in the NSMWA in 2002 along American Canyon Creek (CDFG 2008). It is a regular visitor to Huichica Creek in the Huichica Creek Unit. Suitable habitat for this species is present along American Canyon, Huichica Creek, and Tolay (upper) Creek.

3.8.6 Special-status Fish and Invertebrates

3.8.6.1 Special-status Fish

Several special-status fish and invertebrate species have been collected or are expected to occur within the NSMWA. Special-status fish species addressed in this section include:

- Species listed as threatened or endangered under the state or federal Endangered Species Acts
- Species identified by NMFS or DFG as species of special concern
- Species fully protected in California under the California Fish and Game Code

Special-status fish and invertebrate species that occur or have potential to occur in the NSMWA include Sacramento River winter-run Evolutionarily Significant Unit (ESU) chinook salmon, Central California Coast Distinct Population Segment (DPS) steelhead, delta smelt, Sacramento splittail, hardhead, longfin smelt (*Spirinichus thaleichthys*), river lamprey (*Lampetra ayresi*), green sturgeon, and the freshwater shrimp. **Table 3-9** summarizes special-status fish and invertebrate species that occur or have the potential to occur in the NSMWA. **Figure 12** shows the location of recorded special-status fisheries, invertebrates, and wildlife in the NSMWA.

Sacramento River Winter-Run ESU Chinook Salmon

The Central Valley Winter-run Chinook salmon was listed as endangered on January 4, 1994 (NOAA 1994). Winter-run Chinook salmon are unique to the Sacramento River. They migrate upstream as immature fish during winter and spring and then spawn several months later in early summer (Moyle 2002). Incubation, hatching, and emergence occur in freshwater, followed by migration to the ocean, at which time smoltification occurs. Maturation is initiated and

completed upon return to freshwater habitats. Once maturation is complete, spawning occurs in natal streams. Adults spawn only once and then die.

Critical habitat has been designated for this ESU and includes the Sacramento River from Keswick Dam, Shasta County (River Mile 302) to Chipps Island (River Mile 0) at the westward margin of the Sacramento-San Joaquin Delta; all water from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco–Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. In addition, the critical habitat designation identifies those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration or protection.

Chinook salmon are not likely to occur within Sonoma Creek (Jones and Stokes 2004a, 2004b) or Tolay Creek due to the small size of these streams, as well as other attributes. However, they have been collected in the Napa River and are known to successfully spawn within that system (Jones and Stokes 2004b).

Central California Coast DPS Steelhead

Steelhead trout have been divided into DPSs. Steelhead trout within the Central California Coast DPS were listed as a federally threatened species on August 18, 1997; threatened status was reaffirmed on January 5, 2006. Adult steelhead trout return to rivers and creeks in the region from October to April. Spawning takes place in the rivers from December to April with most spawning activity occurring between January and March. Juvenile steelhead trout remain in freshwater for 1 to 4 years before they out-migrate into the open ocean

Table 3-9. Special-status fish and invertebrate species that occur or have the potential to occur in the NSMWA.

Scientific Name Common Name	Federal[1]	State[2]	Preferred habitat	Potential to occur in the project area
Syncaris pacifica California freshwater shrimp	FE	SE	Pool areas of low elevation, low-gradient streams, among exposed live tree roots of undercut banks, overhanging woody debris, or overhanging vegetation. It inhabits only 17 stream segments in Marin, Napa, and Sonoma Counties.	Medium. Documented in 1981 in Huichica Creek above Neuschwander Rd. Huichica Creek within the NSMWA may be too saline for this species.
Oncorhynchus mykiss Central California coast DPS Steelhead	FT	None	Anadromous. Inhabits cold headwaters, creeks, and small to large rivers and lakes with swift, shallow water and clean, loose gravel for spawning. Requires large pools during summer months. Spawns in spring.	Present. Documented in Napa River.
Hypomesus transpacificus Delta smelt	FT	ST	Brackish water. Found only in the Sacramento-San Joaquin Estuary, as far upstream as the mouth of the American River on the Sacramento River and Mossdale on the San Joaquin River. Downstream as far as San Pablo Bay.	Present. Documented in Pond 3 and San Pablo Bay.
Pogonichthys macrolepidotus Sacramento splittail	None	SC	Freshwater fish that are tolerant of moderate salinities. Found in lower portions of freshwater streams in the Central Valley, Suisun Bay and San Pablo Bay.	Present. Collected in the Napa River.
Mylopharodon conocephalus Hardhead	None	SC	Found in undisturbed areas of larger middle- and low- elevation streams. They are bottom feeders that forage for benthic invertebrates and aquatic plant material in quiet water.	Present. Collected in the Napa River.
Longfin smelt	None	C	Found in upper portion of the water column throughout Suisun and San Pablo bays.	Present. Collected in high numbers in San Pablo Bay.
Green sturgeon	FT	None	Benthic fish that spawn in freshwater and return to sea to rear. Found in brackish to sea water. Little is known about their life history.	Moderate. Some adults and juveniles may occur within the NSMWA.
Lampetra ayresi River lamprey	None	SC	The adults need clean, gravelly riffles in permanent streams for spawning, while the ammocoetes require sandy backwaters or stream edges in which to bury themselves, where water quality is continuously high and temperatures do not exceed 25ºC.	Moderate. Known to occur upstream in Sonoma Creek. It is unclear if spawning adults occur within the system.

[1] United States Fish and Wildlife Service classifications:

FE = Federally Endangered. Species in danger of extinction throughout all or significant portion of it's range.

FT = Federally Threatened. Species likely to become endangered within foreseeable future throughout all or significant

FD = Federally Delisted.

[2] California Department of Fish and Game classifications:

SE = State endangered. Species who's continued existence in California is jeopardized.

ST = State threatened. Species, although not presently threatened with extinction, may become endangered in the foreseeable future.

SC = California species of special concern. Animal species with California breeding populations that may face extinction in the near future.

FP = Fully protected by the State of California under Sections 3511 and 4700 of the Fish and Game Code.

during spring and early summer (Goals Project 2000). However, juveniles can spend up to 7 years in freshwater before moving downstream (Busby et al. 1996). Steelhead trout can spend up to 3 years in saltwater before returning to freshwater to spawn (Barnhardt 1986). Because juvenile steelhead trout remain in the creeks year-round, adequate flows, suitable water temperatures, and an abundant food supply are necessary throughout the year in order to sustain steelhead trout populations. The most critical period is in the summer and early fall when these conditions become limiting.

Critical habitat has been designated for this DPS has been designated and includes stream channels within designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line (NOAA 2005). The NSMWA is within designated critical habitat for the Central California Coast DPS steelhead. They have been collected from the Napa River and Sonoma Creek.

Delta Smelt

Delta smelt were listed as a federally threatened species on March 5, 1993. Delta smelt are small (typically less than 80 mm fork length), slender-bodied fish that are endemic to the San Francisco Estuary. This euryhaline species primarily inhabits the open, surface waters of the Delta and Suisun Bay (USFWS 1995). Although research interest has increased substantially since the species was listed, many aspects of delta smelt biology are still not well understood.

Critical habitat has been designated for this species and includes water and submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Montezuma Slough, and the existing contiguous waters contained within the Delta.

The NSMWA is not within designated critical habitat (USFWS 1994). However, delta smelt has been collected in San Pablo Bay, the Napa River and the internal sloughs and ponds within NSMWA. Three individuals were collected over a 4-year period at the Pond 2A restoration project (Jones and Stokes 2004a, 2004b).

Sacramento Splittail

The Sacramento splittail was listed as federally threatened on February 8, 1999. It was removed from listing on September 22, 2003 (USFWS 2003). However, it remains a state listed species of special concern (CDFG 1995a). Splittail are relatively long-lived (about 5 to 7 years) freshwater fish that are tolerant of moderate salinities (Moyle 1976). Sacramento splittail were once distributed in lakes and rivers throughout the Central Valley (CDFG 1995a). They are now largely confined to the Delta, Suisun Bay, Suisun Marsh, Napa River, Petaluma River, and other parts of the Sacramento-San Joaquin estuary (Caywood 1974, Moyle 1976).

Sacramento splittail have been collected in the Napa River (USACE 2004b), Pond 2A (Jones and Stokes 2004b) and in Pond 1 within NSMWA (Takekawa 2000). They are expected to occur

within riverine habitat, as well as within the interior ponds and sloughs. During spring high flows, splittail may be found spawning on submerged vegetation within the Marshes.

Hardhead

Hardhead is listed as a state species of special concern (CDFG 1995b). Hardhead are large cyprinids, similar to Sacramento pikeminnow, with which they co-occur. Hardhead are bottom feeders that forage for benthic invertebrates and aquatic plant material in quiet water. Hardhead mature following their second year and presumably spawn in the spring (Reeves 1964), judging by the upstream migrations of adults into smaller tributary streams during this time of the year (Wales 1946). Hardhead are typically found in undisturbed areas of larger middle- and low-elevation streams (Moyle and Nichols 1973; Moyle and Daniels 1982). In the Sacramento River drainage, hardhead are present in most of the larger tributary streams as well as in the Sacramento River. They are present in the Russian River and in the Napa River, although the Napa River population is very restricted in its distribution (CDFG 1995b).

Hardhead were collected in the Napa River during 2008 fish surveys (Napa County RCD 2008) 2006). They are expected to occur with riverine habitat present in NSMWA, the Napa River in particular. They are most likely to occur in freshwater portions of the river, upstream of NSMWA.

Longfin Smelt

Longfin smelt is a candidate for listing under the California Endangered Species Act. In the Sacramento-San Joaquin estuary adults and juveniles can be found in water ranging from nearly pure sea water to completely fresh water. The preference of larval smelt for the upper part of the water column is an adaptation that allows them to be swept quickly into food-rich nursery areas downstream, mainly Suisun and San Pablo bays. During years when periods of high outflows coincide with the presence of the larval smelt (e.g., 1980, 1982, 1983, 1984, 1986), the larvae are mostly transported to Suisun and San Pablo bays while in years of lower outflow, they are transported to the western Delta and Suisun Bay (CDFG 1995c). Adults occur seasonally as far downstream as South Bay but they are concentrated in Suisun, San Pablo, and North San Francisco bays.

Longfin smelt has been collected in San Pablo Bay and is one of the most abundant species collected during the DFG surveys (CDFG 1999). However longfin smelt have declined in rank abundance from first or second in most trawl surveys during the 1960s and 1970s to seventh or eighth at present (CDFG 1995c). They can be expected to occur within the open water habitat present in San Pablo Bay.

River Lamprey

The river lamprey is listed as a state species of special concern (CDFG 1995d). The biology of river lampreys has not been studied in California so the information in this account is based on studies in British Columbia (CDFG 1995d). The ammocoetes begin their transformation into

adults during the summer. The process of metamorphosis may take 9 to 10 months, the longest known for any lamprey. Lampreys in the final stages of metamorphosis congregate immediately upriver from salt water and enter the ocean in late spring. Adults apparently only spend three to four months in salt water, where they grow rapidly, reaching 25-31 centimeters TL. The habitat requirements of spawning adults and ammocoetes have not been studied in California. Presumably, the adults need clean, gravelly riffles in permanent streams for spawning, while the ammocoetes require sandy backwaters or stream edges in which to bury themselves, where water quality is continuously high and temperatures do not exceed 25ºC.

A landlocked population of river lamprey may occur in Sonoma Creek (Wang 1986). Spawning has been recorded in Sonoma Creek in the past, however, there is no evidence to suggest that they are present within NSMWA. However, due to their anadromous life history and the fact that they may be present upstream, river lamprey should be considered present within the NSMWA.

Southern DPS Green Sturgeon

The southern DPS green sturgeon was listed as federally threatened on April 6, 2006, by NMFS. This DPS of green sturgeon consists of all coastal and Central Valley populations south of the Eel River, with the only known spawning population in the Sacramento River (NOAA 2006).

Sturgeon

Green sturgeon are a long-lived, slow-growing species as are all sturgeon species. They are an anadromous species and the most marine species of sturgeon, coming into rivers only to spawn and juveniles rear in fresh water for as long as two years. They are found throughout the San Francisco Bay and Delta. Adults feed on benthic invertebrates and to a lesser extent, small fish. Juveniles feed on opossum shrimp and amphipods in the San Francisco Estuary. Green Sturgeon are thought to spawn every three to five years in deep pools with turbulent water velocities and prefer cobble substrates, but can range from clean sand to bedrock. Females produce 60,000 to 140,000 eggs and are broadcast to settle into the spaces in between cobbles. Spawning in the Sacramento River in late spring and early summer (March to July). San Francisco Bay and its associated river systems contain the southern-most spawning population of green sturgeon. Green sturgeon spawning occurs predominately in the upper Sacramento River. Once green sturgeon out-migrate from freshwater they disperse widely. They occur in the coastal waters of the Pacific Ocean off California and in coastal rivers. Sturgeon tagged in the Sacramento River are primarily captured in coastal and estuarine waters to the north. The principal factor for decline of the Southern DPS is the reduction of the spawning area to a limited area of the Sacramento River. A number of presumed spawning populations (the Eel River, South Fork Trinity River, and San Joaquin River populations) have been lost in the past 25 to 30 years.

Portions of the NSMWA along San Pablo Bay may contain green sturgeon. Open water habitats adjacent to tidal marshes are important habitats for both green and white sturgeon (Goals Project 2000). Several sturgeon carcasses were observed during surveys of lower Tolay Creek. These were not definitively identified and were recorded as sturgeon sp. (Takekawa et al. 2002).

3.8.6.2 Special-status Invertebrates

Freshwater Shrimp

The California freshwater shrimp (*Syncaris pacifica*) is a state-listed and federally listed endangered species. It can be found in pool areas of low elevation, low-gradient streams, among exposed live tree roots of undercut banks, overhanging woody debris, or overhanging vegetation. It inhabits only 17 stream segments in Marin, Napa, and Sonoma Counties. The species is known to occur in Huichica Creek and portions of Sonoma Creek (Jones and Stokes 2004a, 2004b).

3.9 CULTURAL RESOURCES

This section describes the prehistoric and historic uses of the NSMWA, as well as the results of the background literature review and reconnaissance level inspection.

3.9.1 Prehistory

Lillard et al. (1939) developed an early systematic cultural chronology for Central California. The Central California Taxonomic System (CCTS), as their culture chronology came to be known, identified three broad divisions, or Horizons, among sites in the Sacramento Valley, based primarily upon analyses of burials and associated artifacts. The Early, Transitional (later known as Middle), and Late Horizons were viewed as both cultural and chronological. These Horizons framed much of the cultural chronological thinking about archaeological sites in Central California for several decades.

By the late 1940s, the need for refinement in this scheme as applied to the San Francisco Bay region was established. Analysis of assemblages from deep, well-stratified sites such as ALA-309 (the Emeryville Shellmound) offered opportunities for this kind of refinement. Notable in this regard is Beardsley's typological examination of mortuary data in the Bay Region (1954). Beardsley examined burial lots from several shellmound sites throughout the Bay Region and characterized each burial as to stratigraphic position, burial position and orientation, and types and numbers of grave associations. Based on these analyses, Beardsley identified two distinctive components in assemblages from the Emeryville cone: the Ellis Landing Facies, lying in the lower portion of the deposit, which he associated with the Middle Horizon in the CCTS; and an upper component that he described as the Emeryville Facies of the CCTS early Late Horizon. Beardsley noted that a third component, described as the Fernandez Facies, is weakly represented in the uppermost levels of the mound. Distinctive artifacts and other identifiable

traits are associated with each of these Facies, such that it is possible to identify similar components, presumably chronologically related, among other archaeological sites in the region.

Beardsley's analyses were hindered by two major factors: his work was undertaken before the advent of radiocarbon assay, so he lacked the means of obtaining absolute dates for archaeological components. Further, he sought to tie his analyses in many respects to the CCTS, the applicability of which has since been questioned. Nonetheless, the components Beardsley defined have stood up very well under more recent analyses, although discussion continues regarding the appropriate relationship between the Facies Beardsley defined and larger chronological and cultural units. There has been some difficulty in correlating absolute dates obtained through radiocarbon assays with the relative dates tied to Facies linked to the CCTS.

Fredrickson (1973, 1974) reexamined the CCTS and proposed a cultural classification scheme to address early cultures of the North Coast range. Expanding on his earlier work at sites such as CCO-30 south of the city of Walnut Creek, Fredrickson introduced the concept of "Pattern" in his 1974 article "Cultural Diversity in Early Central California: A View from the North Coast Range" (Fredrickson 1974). "Pattern" is a term for a chronological era. Fredrickson defined three major cultural patterns: the Windmiller, the Berkeley, and the Augustine (West and Welch 1996). Windmiller Pattern refers to earlier prehistoric sites and is restricted to the eastern Delta, the area around the Camanche Reservoir, and adjacent areas of the lower Sacramento Valley from the middle of the Cosumnes River to Stockton. Windmiller relates to the Early Horizon of the CCTS, while the Berkeley Pattern can be equated with the Middle Horizon in the lower Sacramento Valley. However, some early phases could relate to the early period in the San Francisco Bay Area. The Augustine Pattern refers to sites occupied late in the prehistoric (West and Welch 1996). Patterns are subdivided into "Periods," with the Berkeley Pattern extending from the Lower through the Middle and Upper Archaic periods, and the Augustine Pattern represented by the Lower and Upper Emergent periods.

The prehistory of the San Francisco Bay Region is not as well known as other areas due to its history of intensive urban development. However, over the past few years, perception of this region's history has changed rapidly, partly as a result of intensive fieldwork performed to comply with environmental laws (Jones and Stokes 2003b). Recent investigations have led researchers to believe that this part of California was inhabited in the early Holocene times, emphasizing that older archaeological sites may exist on the submerged continental shelf or below the waters and sediments of the San Francisco Bay (Jones and Stokes 2003b). By examining and comparing the archaeological finds from sites in the Central Valley of California, the Monterey Coastal region, and the San Francisco Bay Area itself, however, a few generalizations can be made about the people who inhabited this region.

Typically, sites are found in settings adjacent to water resources, which would have placed humans in close proximity to a wide variety of plant and animal resources. Subsistence focused on hunting and gathering, and the typical diet most likely included fish, shellfish, deer, and gathered seeds. Based on the numerous grave goods found with human burials from this early

period (typically found in a prone position and facing west), some archaeologists have concluded that trade networks with other groups had already been established and ceremonialism was an important aspect of daily life. Artifacts that might be found in association with a burial might include large projectile (spear or dart) points, fishing weights, hooks, animal bone, seed grinding implements, and shell beads.

About 4,000 BP, the archaeological sites from the San Francisco Bay Area and surrounding regions begin to suggest a greater specialization. It has been suggested that this period, referred to as Windmiller, is associated with an influx of peoples from outside of California. The archaeological evidence suggests these early populations employed technologies adapted to river-wetland environments (Moratto 1984). Typical Windmiller sites are often situated in riverine, marshland, and valley floors, settings that offered a variety of plants and animal resources. These sites often contain burials that are extended ventrally and oriented to the west. Burial artifacts include a variety of fishing paraphernalia (net weights, spear points, and bone hooks), large projectile points, as well as faunal and large and small mammal remains.

The subsequent Middle Horizon or Berkeley Pattern covers a period from 2,500 to 1,500 years ago in the Northern California Delta area. Sites from this period are more numerous and are better documented in the region. This development is thought to represent utilitarian cultural developments and geographic spread from the valley throughout the Bay Area (Jones and Stokes 2003b). As described by Allan et al. (1997), sites from this period include deeply stratified midden deposits, containing large assemblages of milling and grinding stones for the processing of vegetal resources, as well as smaller and lighter projectile points. The ratio of grinding implements and large shellmounds to projectile points indicates that gathering was emphasized, and hunting played a lesser role in subsistence strategy (Jones and Stokes 2003b). Further distinguishing traits from earlier patterns include artifacts such as slate pendants, steatite beads, stone tubes, and ear ornaments. A shift in burial patterning is also evident with variable directional orientation, flexed body positioning, and a general reduction in mortuary goods (Fredrickson 1973; Moratto 1984).

By AD 500, the Berkeley Pattern had developed into the Augustine Pattern. This development does not appear to represent a population replacement, but rather, a diffusion of new traits into the Bay Area (Jones and Stokes 2003b). The pattern is characterized by intensive hunting, fishing, and gathering, a focus on acorn processing, large population increases, intensified trade and exchange networks, more complex ceremonial and social attributes, and the practice of cremation in addition to flexed burials. Moratto (1984) adds that grave goods were often burned in the burial pit before interment of the body. As pointed out by Allan et al. (1997), certain artifacts also typify the pattern: bone awls for use in basketry manufacture, small notched and serrated projectile points, the introduction of the bow and arrow, occasional pottery, clay effigies, bone whistles, and stone pipes. Significant variation in grave wealth suggests discrepancies in wealth and status. The archaeological record continues to suggest reliance on the littoral and estuarine environment afforded by the Bay Area (Jones and Stokes 2003b).

3.9.2 Ethnography

The majority of the project area is the traditional ethnographic territory of the Patwin. However, the Coast Miwok also inhabited the lands of northern San Pablo Bay, in the western project areas in Sonoma County.

3.9.2.1 Patwin

Patwin territory included the Southern portion of the Sacramento River Valley to the west of the river, from the town of Princeton south to San Pablo and Suisun bays. From north to south, it extended 90 miles, and from east to west, it extended 40 miles, covering the banks of the Sacramento River, the flat, open grassland plains with occasional oak groves, and the lower hills of the eastern Coast Range mountain slope, rising to an elevation of 1400 feet (Johnson 1978).

"Patwin" is a native word that means "people" and was used by several tribelets in reference to themselves. It does not denote a political unity. The term was suggested initially by Powers (1877) as a convenient name for those groups who displayed a close linguistic and cultural resemblance, but were distinguishable from, those Wintuans inhabiting the northern half of the western valley. The Wintuan language has been further divided into North, Central, and South Wintuan; the Patwin are classified as Southern Wintuan.

The maximum political unit for the Patwin was the tribelet, which consisted of one primary and several satellite villages. Each tribelet had a definite sense of territoriality and autonomy, and each tribelet sustained brief cultural differences from the others. Within the tribelet were several political and social distinctions, including a chief who oversaw village activities; this position was often determined by inheritance from father to son (Johnson 1978).

Patwin villages contained four main types of permanent structures: the dwelling or family house; the ceremonial dance house, which was usually built at a short distance to the north or south end of a village; the sudatory (sweat house), which was positioned at either the east or the west of the dance house; and the menstrual hut, which was placed on the edge of the village, farthest from the dance house. All of these were earth-covered, semi-subterranean structures with either an elliptical or circular shape (Johnson 1978).

The principal subsistence activities of the Patwin were hunting, fishing, and the gathering of wild plants. As among many other California cultures, a primary staple was the acorn. Hill, mountain, and occasionally live oak were gathered. Pulverized acorns were leached by pouring cold water over the meal spread in a sand basin. After processing, it was made into soup or bread. In addition to acorns, buckeye, pine nuts, juniper berries, Manzanita berries, blackberries, wild grapes, and other plants were collected at various times of the year. Each village had its own location for these food sources, and the village chief oversaw the procurement of food for the village (Johnson 1978).

Population estimates for Patwin groups, from pre-contact until 1833, is over 15,000 (Kroeber and Heizer 1932; Cook 1955). The Patwin were in contact with the Spanish missions by the late

eighteenth century, and some of the earliest historic records of the Patwin are found among mission registers of baptisms, marriage, and deaths of Indian neophytes. Mission San Jose, established in 1797, along with Mission Dolores, actively proselytized Patwin from their southern villages, and Mission Sonoma, built in 1823, also baptized neophytes, until the secularization of all missions by the Mexican government from 1832 to 1836. Afterwards, many tribal territories were divided into individual land grants (Johnson 1978).

The U.S. conquest of California (1846 to 1848) was followed by a massive influx of American settlers into Patwin territory, increasing pressure on the indigenous population. To facilitate the development of ranching, agriculture, mining, and large settlements, American policy toward the Patwin was generally one of removal to reservations. However, some Patwin were able to assimilate themselves, at least partially, into White culture through working as ranch laborers (Johnson 1978).

A decline in Patwin population continued into the 20th century, whereby in 1923 to 1924, Kroeber could find only approximately 200 Patwin, all living in the northern half of Patwin territory. As of 1972, the Bureau of Indian Affairs census listed only 11 Patwins for the entire territory. However, such estimates often include only Patwin with one-quarter or more descent (as in Kroeber and Heizer 1932), excluding those persons with less than one-quarter Patwin descent (Jones and Stokes 2003b). Three reservations (Colusa, Cortina, and Rumsey rancherias) remain today; however, these three are often described as “Wintun” and were mostly occupied by descendants of other groups (Johnson 1978). Elements of Patwin culture may be, however, preserved in contemporary Indian cultures by way of pan-Indian organizations and living descendants of the Patwin (Castillo 1978).

3.9.2.2 Coast Miwok

Coast Miwok territory centered in Marin and adjacent Sonoma County, extending from Duncan’s Point on the Sonoma County Coast to the end of the Marin County Peninsula (Kroeber 1925). To the east Coast Miwok territory extended east as far as midway between the Napa and Sonoma Rivers (Jones and Stokes 2003b).

The Coast Miwok language, a member of the Miwokian subfamily of the Utian family, is divided into two dialect groups: Western (Bodega) and Southern (Marin), with the Southern dialect further divided into valley and coast (Kelly 1978).

There appears to have been little overall tribal organization within Coast Miwok villages. Larger villages had a chief, who, along with four elderly women, tutored an incipient headman, and, when the successor was ready to take over, the incumbent withdrew, or a poisoner was hired to liquidate him (Kelly 1978). Many villages had two important female leaders. One coordinated the Acorn Dance (a dance performed to bring good luck to the collection of acorns and other fruits), dominated the Sunwele Dance (a dance involving spirit impersonation), and was deeply involved in the Bird Cult (an aspect of the special attitudes towards birds) (Kelly 1978). The

second female leader was the head of the women's ceremonial house, oversaw construction of the dance house, and coordinated many festivals and dances for the entire village (Kelly 1978).

Coast Miwok villages all contained dwellings, or family houses, and larger villages had circular sweathouses dug four or five feet into the ground. In populous settlements, the so-called secret societies had a ceremonial chamber, or dance house, as well (Kelly 1978).

The principal subsistence activities of the Coast Miwok, like the Patwin, were hunting, fishing, and the gathering of wild plants. Various fish and fowl were acquired based on seasonal availability. Villages were adjacent to shores, lagoons, or sloughs, but the Coast Miwok sought game and plants in the hills during the summer (Kelly 1978).

Spanish explorers made contact with the Coast Miwok in the late 1700s. By 1776, the Franciscan fathers of the San Francisco mission began forced conversions of Native Americans to Christianity and brought Coast Miwok to mission lands, causing a partial abandonment of native settlements. Subsequent ranching and settlement by Mexicans and Americans further displaced Coast Miwok from their homes; many Miwok died from epidemic diseases and the consequences of resistance of the new settlers (Bean and Rawls 1983). However, during the early years of the American period in California, some Coast Miwoks were able to find work in sawmills and in the fields (Kelly 1978).

Cook estimated that the Coast Miwok population declined from approximately 2,000 persons prior to European contact to only five individuals by 1920 (Cook 1976). The National Park Service, the Miwok Archaeological Preserve, and individuals of at least partial Coast Miwok descent have recreated the village of Kule Loklo (Bear Valley) on the Point Reyes National Seashore. Dances and local festivals reflecting Coast Miwok traditions are now held at Kule Loklo (Eargle 1986).

3.9.3 History

The majority of the project area lies with Napa County, with some parcels located in Sonoma County to the west, and Solano County to the south.

3.9.3.1 Napa County

The Napa Valley was once part of "Alta California," claimed by the Spanish Empire. Spain gave up Alta California to Mexico in 1821 when Mexico separated from its mother country. The newly independent Mexican government sent Padre Jose Altimira and Don Francisco Castro to select a site suitable for a new mission north of Yerba Buena (San Francisco), where the native population, used to warm, dry weather, had great difficulty adapting to the San Francisco climate. After traveling through the Napa and Sonoma region, they decided that Sonoma would be the best place for the new mission, as there was abundant timber and water, and Napa was determined to be more suitable for cattle tending (Weber 1998).

In 1836, Governor Mariano Chico signed the first land grant in the valley, for Rancho Caymus, to the ownership of George Yount. Later that year, Chico granted Rancho Entre Napa, west of the Napa River, to Nicolas Higuerra, one-time solider at San Francisco and the deputy mayor of Sonoma. In 1848, Nathan Coombs bought the northeast corner of the rancho from Higuerra, surveyed the land, and laid out the plans for the city of Napa. Following Statehood in 1850, Napa became one of California's original 27 counties, established on February 8 of that year (Coy 1973; Kyle 1990).

3.9.3.2 Solano County

Solano County is also one of California's original 27 counties and has retained its original boundaries over time. The first county seat was the City of Benicia.

In 1839, Jose Francisco Armijo petitioned for three square leagues of land in the Suisun Valley in northern California. The following year, he received the grant to Rancho Tolenas from Governor Alvarado. Armijo acquired the title to the 13, 315-acre rancho upon his father's death in 1850. In 1858, Captain R.H. Waterman acquired land in the Armijo grant. Shortly after getting title to the land, he offered Solano County 16 acres for use as a new county seat. The majority of citizens preferred that the county seat be in a more centralized location than Benicia, so the voters accepted Waterman's offer, making the new town of Fairfield (named after Waterman's hometown in Connecticut) the new county seat, where it has remained to the present (Wood Allen & Co. 1879; Hunt 1926; Coy 1973; Kyle 1990).

3.9.3.3 Sonoma County

Sonoma County was one of the original 27 counties of California, created in 1850 at the time of statehood. The Russians, who had moved south from Alaska in search of otters, built the first permanent, non-native settlement in Sonoma County. In 1812, a group landed at Bodega Bay and founded a settlement north from there. They named the fort "Ross," an old name for "Russia".

The Spanish, who were making their way up from Mexico along Coastal California, were inspired by the Russian settlement to complete the development of their missions. Father Jose Altimira, a priest at Mission San Francisco, built the Francisco Solano Mission, also known as the Sonoma Mission, in the present-day town of Sonoma. By that time, Mexico had declared its independence from Spain. Shortly after, the Mexican government secularized the mission system, making the Sonoma Mission the last and northernmost one built, and the only one built under Mexican rule (Wood 2005).

General Mariano Guadalupe Vallejo was sent to Sonoma in 1835 to oversee the secularization of the Sonoma Mission. Over the next 11 years, he settled much of Sonoma County, taking 66,000 acres in Petaluma for himself, developing ranchos, and parceling out land to his extended family. Much of the livestock and Indian laborers from the secularized missions were absorbed by Vallejo's ranchos.

In the summer of 1846, a group of American settlers rode into Sonoma to confront General Vallejo, kidnapping and detaining him and others for several months. This group of pioneers proclaimed a new republic, creating a flag with the words "California Republic" and an image of a grizzly bear. For 22 days, the bear flag flew over Sonoma as the settlers declared California an independent republic. As the conflict became part of the larger Mexican-American war, Mexico eventually lost the war and ceded California to the United States (Wood 2005).

3.9.3.4 History of the San Pablo Bay Tidelands

The tidelands of the northeast part of San Pablo Bay comprise about 94 square miles of marsh and extend into parts of Napa, Solano, and Sonoma Counties. A Spanish expedition in 1823, led by Francisco Castro, was the first recorded nonnative exploration into the area. Following California statehood in 1850, these lands became part of the state holdings, and remained mostly undeveloped through the 1850s and 1860s. During this time, they were used primarily for hunting duck and other waterfowl for San Francisco markets (Hayes 1995).

In 1861, the California legislature passed a law which allowed the formation of swampland reclamation districts, and created a state board of swampland commissioners to supervise private reclamation projects. By the end of 1862, the state contained 38 swampland districts covering over 485,000 acres of land. Under pressure from land speculators and wheat farmers, however, the 1866 legislature decommissioned the board and passed the responsibility of overseeing reclamation projects to the various counties. In 1868, when the legislature dropped a 640-acre limit on the amount of "swampland" an individual could acquire (known as the Green Act), an immediate boom in private land acquisitions spread across the state (Jones and Stokes 2003b).

Between 1868 and 1871, most of the state's swampland holdings were privately owned, as a result of the Green Act, which also allowed the formation of local reclamation districts authorized to purchase state swampland and tidelands. In 1872, the newly incorporated Pacific Reclamation Company reclaimed some 12,000 acres of San Pablo Bay marsh west of Sonoma Creek with a system of levees, dams, ditches, and sluice gates. By 1877, the San Pablo Land Company had reclaimed 5,000 acres in the area (Kelley 1989; Hayes 1995). Reclamation continued from the 1880s to around 1910. The first crop grown in reclaimed marsh land was barley; and from the 1890s to the 1920s, oat hay and oats as grain were also grown in this area (CDFG 1977).

The largest of California's sales of the islands east of Sonoma Creek and within the project area was "Survey No. 569" to Jacob Hinckley, which generally included the lands of (modern) Island No. 1 and Knight Island. The second largest parcel, known as "Survey No. 115", covered Little Island, Island No. 2, and a portion of Russ Island. Vast landholdings within the project area were acquired by William S. Chapman, John W. Pearson, and George A. Nourse through a series of deals by 1872. During the 1870s, they continued business enterprises in other areas of the state, and gradually sold off their San Pablo Bay tidelands holdings by the mid-1890s (Jones and Stokes 2003b).

By the late 1800s, most marshland in the project area was diked, drained, and being used for livestock grazing and farmland. In 1904, Frank E. Knight acquired 7,000 acres of tidelands near Vallejo and constructed a series of levees and dykes to reclaim the land, which he did successfully, in 1926.

Although most of the marshland was eventually reclaimed, the soil along San Pablo Bay was unsuitable for most orchard-type agriculture. In general, the ranches in this area adapted to the rich peat soil of the region and grew grain crops, mostly alfalfa hay for the dairy markets in the San Pablo and San Francisco Bay area (Hayes 1995). The transition to automobiles during the 1920s caused a decrease in hay shipments, and the subsequent conversion of many ranches to more intensive crops led to the division of some of the larger holdings (Jones and Stokes 2003b).

3.9.3.5 Duck Hunting and Duck Clubs

For centuries, parts of California, including the tidal marshes near the San Francisco Bay, have served as the main wintering duck quarters for migratory waterfowl in the Pacific Flyway. As early as the 1850s, duck hunters traveled to the area to shoot waterfowl commercially for the San Francisco markets (Jones and Stokes 2003b).

Duck hunters typically relied on a variety of duck blinds, which were either temporary or permanent structures, based on their location in the water. In deep, large marshes covering a large area, duck blinds were elevated structures that varied in size and were supported by platforms resting on piles flush with the surface of the water. Many allowed the hunter to move with the ducks as they traveled in search of food. Small blinds, typically three to five feet, were partially hidden by netting or tules and rushes and often included a rail to support the gun and the shooter. Shallow marshes generally featured sunken blinds. Hunters also converted boats into blinds by anchoring the vessel and covering it with marsh vegetation. As these structures were abandoned or destroyed in response to the changing marshland (through silt deposits and flooding), new blinds were constructed to take their place (ibid).

Duck clubs were an outgrowth of duck hunting and were first established in California as a result of unregulated game fowl hunting. By the 1870s, the number of waterfowl in California had drastically decreased due to over-hunting by sportsmen and market hunters. Urban sport hunters purchased tidelands that were generally considered unfit for agriculture, and modified these lands to attract waterfowl. Over the years, the original founders or their descendants maintained many of these early duck clubs. The need to build dikes and levees to create the ponds, for blinds, planks, and clubhouses, and to have many small boats, rendered duck clubs expensive to own and operate, and therefore, were primarily a sport for the well-to-do. In addition, hunting was often restricted to certain days of the week and even to specific hours, restrictions that were necessary to allow the duck population to reproduce.

One of the early 20th-century duck clubs in the San Pablo Bay tidelands was the Fleishacker Club, also known as the Detjen Duck Club. It is the only remaining duck club adjacent to Route 37, in an area that once contained many. (Others were purchased, and/or flooded by activities

related to other developments and/or restoration [Wyckoff 2008]). This duck club was located to the west of Island No. 1, just south of the Napa/Solano County line. It was established by the Field and Tule Land Company, and by the 1930s, the complex included a large clubhouse and other facilities. The name came from a short-term property owner during the 1940s. However, the name was changed to the Detjen Duck Club after H. Louis Detjen purchased the property in the 1950s. See **Appendix D**, Primary Record P-48-212/P-28-1324 for more details.

Other historic duck clubs in the project area include the West End Club, a turn-of-the-century duck club that was located on Sonoma Creek near SR 37 (CERES 1996); and the Little Island Farms Club (also known as the Pale Ale Club), which was located south of pond 6A. Club holdings included a lodge, outbuildings, and 300 acres of property. The club was most likely established during World War II, as prior use of the land was for farming on reclaimed marshland (Huffman 2008a).

Another duck club in the San Pablo Bay tidelands was the Can Duck Club. This club was established in 1898 at Pond 2 and was known as the Hanneberry Duck Club, after the ranch of the same name (Hart 2007). From 1898 to 1955, the Hanneberry Duck Club and its successors consisted of members and owners primarily from the upper class, which would have represented the typical socioeconomic status of other duck clubs of that era (Allen 2007).

Leslie Salt bought and flooded the former Hanneberry Ranch in 1952, inheriting the hunting establishment as well. The club was renamed the Can Duck Club in July 1955 (after the Canvasback) and was organized as a non-profit corporation. During this time, the Club was converted to deep water and became a diving waterfowl habitat, incorporating such changes as disallowing wading and requiring the use of large boats and motors; heavy elevated blind construction (and continual re-construction); and the necessity of handling three-pound weights with 200 bird decoy spreads (Hart 2007). Membership in the Club, restricted to fifty members per year, consisted of individuals of various skills and trades, who were often former “unattached slough shooters”; that is, individuals who did not belong to any established club, but were looking for a more stable, less rugged environment than the one often encountered by a freelance duck hunter (Allen 2007).

DFG acquired the land in 1994. The Club received two five-year lease extensions; the last of which expired in July 2007 (Hart 2007). Now the property is currently open to public access.

Duck hunting continues to this day on the Giovannoni property, which is located on Napa Slough/Devils Slough, north of pond 6A (Huffman 2008a; Giovannoni 2008). It was purchased by the Giovannoni family in the early 1950s, and remains in their care. The Giovannoni land consists of seasonal marshland which is dry for most of the year, but is flooded in October, and remains as such, throughout duck-hunting season. The Giovannoni family also performs some maintenance of the land, in the form of vegetation management. The property is privately owned and not open to the public (Giovannoni 2008).

3.9.3.6 The Salt Industry

The manufacture and processing of salt as an industry in the San Francisco Bay Area began in the mid-1850s. Prior to that time, salt was gathered from natural salt pans or "hot ponds" in the marshes at the bay edge. In 1854, the bay's first artificial salt pond was created from 73 acres of marsh in Alameda County (Jones and Stokes 2003b).

The discovery of the Comstock Lode in Virginia City, Nevada in 1859 was the first major spur to the California salt industry, as salt was used in the industrial mining process of treating silver ore. The meat and fish curing industry of San Francisco used imported salt due to its superior quality (Ver Plank 1958).

The Leslie Salt Refining Company was established in 1901 and was one of the first to operate on the west side of San Francisco Bay. Two other salt companies were in operation at this time: the California Salt Company, the Continental Salt and Chemical Company. The companies began merging with smaller salt farms and buying production companies. In 1924, the three companies merged to form Leslie-California Salt Company, and in 1936, the company was incorporated, and acquired the assets of both the Leslie-California Salt Company and the Arden Salt Company (Ver Plank 1958).

Until the early 1950s, Bay Area salt production was concentrated in Alameda, San Mateo, and Santa Clara Counties. In 1952 to 1953, the Leslie Salt Company acquired more than 10,000 acres in the vicinity of the Napa River and Sonoma Creek. To create the salt ponds, the company raised several of the existing levees, built cross levees, and created intake channels to flood much of the property (Jones and Stokes 2003b).

In 1978 to 1979, the Minnesota-based Cargill Salt Company (Cargill), an agricultural products corporation, acquired the company, maintaining its existing facility, buildings, internal systems, and river levees. In 1994, Cargill sold or donated their San Pablo Bay holdings to the state of California (Hayes 1995). The DFG acquired the Napa Plant Site from Cargill in March 2003 as part of the larger State of California, federal, and private sponsored purchase of 16,500 acres of salt ponds in the San Francisco Bay estuary.

3.9.4 Cultural Resources Literature Search

In compliance with CEQA Section 15126.4 and Federal Section 106 compliance for cultural resources, an archaeological investigation was performed for the proposed LMP. The archaeological investigation consisted of a literature review to identify any prior surveys conducted in or adjacent to the project units; any previously recorded archaeological sites that could be impacted by the undertaking, and a reconnaissance level inspection to locate and ascertain the current state of previously recorded sites and to locate sites that have not been previously recorded.

The literature review was conducted at the NWIC, which is located at Sonoma State University in Rohnert Park. The NWIC is the CHRIS center for 16 counties, including Napa, Solano, and Sonoma. The record search included the following sources:

- Sites in the NSMWA or within 0.25-mile radius of the project units
- Previous investigations in or within 0.25-mile radius of the project units
- Office of Historic Properties Directory
- California Inventory of Historical Resources
- Historic maps

The NWIC records search resulted in the identification of 11 prehistoric sites and 9 historic sites in the NSMWA or within a ¼-mile radius of the project units.

Table 3-10 lists the previously recorded sites within the vicinity of the NSMWA project units as identified by the NWIC. **Table 3-11** lists the previous cultural investigations within the vicinity of the project units. **Appendix D** contains the site records and survey report information provided by the NWIC.

In addition to the formal literature review noted above, Tom Huffman, Wildlife Habitat Supervisor 1 of the Napa-Sonoma Marshes and the Petaluma Marshes Wildlife Area, stated that in the 1990s, he found a "charmstone on the eastern pond 1a levee, which an anthropologist from Sonoma State roughly dated at 3,000 BC." He also noted that, "A few years later, I found an obsidian spear point on the western pond 5 levee." (Huffman 2008b). Mr. Huffman did not report any further findings or associations with these isolated artifacts. Due to the fact that they were discovered on artificial landforms [levees], the provenience (location) of these isolates is compromised, and is not likely an indicator of additional cultural material in the Napa Salt Ponds.

3.9.5 Results of the Reconnaissance Level Inspection

The reconnaissance level inspection for the NSMWA LMP was undertaken on December 10, 2007. The inspection consisted of an effort to locate and record previously unidentified archaeological sites through cursory inspection of likely environmental locations and to relocate previously identified sites to evaluate their current condition. However, this survey was not intended to, nor was it undertaken in a manner that would constitute an intensive pedestrian survey, to inventory all visible and apparent cultural resource manifestations.

The majority of previously recorded cultural resources identified by the NWIC are located within a 0.25-mile radius of the project units, but outside of the LMP limits. This LMP is not expected to result in any ground-disturbing activities and will avoid any effect to the built environment. For these reasons, the inspection focused primarily on attempting to relocate previously recorded prehistoric resources within the project units.

Table 3-10. Previously recorded cultural resources in the vicinity of the NSMWA.

County	Quad	Site Number(s)	Site Type	Description	Within Project Footprint?
Napa	Cuttings Wharf	P-28-197 CA-NAP-230	Prehistoric	A shellmound originally recorded in 1907 by N.C. Nelson. Artifacts included shell and obsidian flakes. Revisited and relocated in 2005- area partially covered in a gravel driveway.	Yes
Napa	Cuttings Wharf	P-28-1284	Historic	The burned remains of a residence that may have been the original 1870s homestead structure; a distinct area of burnt materials include glass, ceramic sherds, and metal. Recorded in 2005.	Yes
Napa	Cuttings Wharf	CA-NAP-585H	Historic	The probable remains of Thompson's (Suscol) wharf, built in the late 1850s. The site is composed of at least 36 pilings remaining in the river, some with metal stakes protruding from the top of the piling. Recorded in 1980.	No; within the 0.25-mile search radius
Napa	Cuttings Wharf	P-28-1186	Historic	Stanly Ranch; the former ranch complex of Judge John Stanly; property contains a ranch house & several barns. The resource includes a 1.5-mile section of Stanly Lane that is lined on both sides with Eucalyptus trees and several small bridges over culverts.	Partially
Napa	Cuttings Wharf	CA-NAP-598H	Historic	An earthen ditch, 40-45" wide, 9" deep; appears to slope slightly downhill from apparent source at drainage to present terminus at Hwy 29 fill. Recorded in 1981.	No; within the 0.25-mile search radius
Solano	Cuttings Wharf	P-48-110 CA-SOL-269	Prehistoric	A sparse collection of lithic artifacts (flakes) at Slaughterhouse Point originally recorded by N.C. Nelson in 1907, but not field-checked by him. Re-recorded in 1960 and again in 1977 prior to residential development in the area.	Partially
Solano	Sears Point/ Cuttings Wharf	P-48-212/ P-28-1324	Historic	The "Fleishhacker Club," a ca. 1900 two-story gabled structure with wood frame construction, located on 357.87 acres of reclaimed marshland, defined by four levees. Other structures include three sheds, one with a gabled roof; a windmill, and a footbridge. The main structure has modern additions. The Club is also known as the Detjen Duck Club. Site was recorded in 1995.	No; within the 0.25-mile search radius
Solano	Cuttings Wharf	P-48-213	Historic	"Camp" structures associated with ranch and farming operations on Island No. 1, built mid-1920s. Structures include a large barn, a bunkhouse, a milk barn, lean-to sheds, corrugated shelters, and a pumphouse. Some buildings were destroyed in the 1980s.	No; within the 0.25-mile search radius
Solano	Cuttings Wharf/ Mare Island	P-48-462 P-28-1021 CA-SOL-408	Historic	The Cullinan Ranch North Levee; a dirt structure built to assist in the drainage of a tidal marsh to create suitable agricultural fields, probably constructed in the 1920s.	No; within the 0.25-mile search radius
Sonoma	Sears Point	C-164	Prehistoric	A shellmound site originally recorded by N.C. Nelson.	No; within the 0.25-mile search radius
Sonoma	Sears Point	CA-SON-207	Prehistoric	A shellheap located near Sears Point, originally recorded by Nelson in 1907. The site was revisited in 1983; only shell fragments & fire cracked rock were observed. Site noted as disturbed by animals & cattle trails.	No; within the 0.25-mile search radius
Sonoma	Sears Point	CA-SON-208	Prehistoric	A "shellheap" located near Sears Point, originally recorded by Nelson in 1907. Artifacts found include obsidian flakes.	No; within the 0.25-mile search radius

Table 3-10. Previously recorded cultural resources in the vicinity of the NSMWA.

County	Quad	Site Number(s)	Site Type	Description	Within Project Footprint?
Sonoma	Sears Point	CA-SON-209	Prehistoric	A campsite with shell fragments; originally recorded by Nelson in 1907, located near Tubb's Island.	No; within the 0.25-mile search radius
Sonoma	Sears Point	CA-SON-217	Prehistoric	A "shellheap" originally recorded by Nelson in 1907; consisted mainly of "black earth and rock with a very little shell- among which oyster".	No; within the 0.25-mile search radius
Sonoma	Sears Point	CA-SON-225	Prehistoric	Two burial mounds originally recorded by Nelson in 1907.	No. Within the 0.25-mile search radius
Sonoma	Sears Point	CA-SON-226	Prehistoric	A campsite originally recorded by Nelson in 1907: "a large, circular knoll a little west of Merazo, but no good evidence of its genuineness to be had".	No; within the 0.25-mile search radius
Sonoma	Sears Point	P-49-199/ CA-SON-227	Prehistoric	A "shellheap" originally recorded by Nelson in 1907; revisited in 1997 by the Anthropological Studies Center at Sonoma State Univ.	No; within the 0.25-mile search radius
Sonoma	Sears Point	P-49-1862 CA-SON-2226	Prehistoric	A prehistoric site consisting of a lithic scatter adjacent to a natural spring which has been capped with concrete housing.	No; within the 0.25-mile search radius
Sonoma	Sears Point	P-49-2834 CA-SON-2322H	Historic	A 1.9-mi. segment of the present-day Northwestern Pacific Railroad and the remains of the Greenwood Station. The former Marin & Napa RR Company built the line in the late 19th c. The Greenwood Station is on the former Monroe Greenwood property; remains include railroad ties, glass & ceramic fragments; construction debris, & slag deposits.	No; within the 0.25-mile search radius
Sonoma	Sears Point	P-49-3278	Historic	The Dickson Ranch Complex- a 19th-c. house and several associated buildings, dating as early as 1887. Structures include barns, bunkhouses, and outbuildings.	No; within the 0.25-mile search radius

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Survey Reports within the Project Area			
An Archaeological Survey of Possible Dredge Spoil Disposal Sites for the Napa River Channel Improvement Project	89	Moratto (1974)	Huichica Creek Unit; Southern Crossing Unit
Archaeological Assessment of the Sonoma Valley Reclamation Project, Sonoma County, California	278	French and Frederickson (1976)	Ringstrom Bay Unit
Cultural Resource Assessment of the Napa-American Canyon Wastewater Reuse Program	1200	Peak & Associates (1978)	Huichica Creek
A Preliminary Cultural Resources Study of the Lakeville-Sobrante 230 KV T/L Project Area	1834	Eisenman, Gerike, and Goodrich (1979)	White Slough Unit, Sonoma Creek Unit/American Canyon Unit
A Cultural Resources Survey of Five Napa River Disposal Sites	1908	Rudeo (1980)	Southern Crossing Unit and Bull Island (not in project area)
An Ethnographic Survey of Native American Cultural Resources along Pacific Gas & Electric's Proposed Lakeville-Sobrante 230 KV Transmission Line in Sonoma, Marin, Napa, Solano, & Contra Costa Counties	1980	Patterson, Goodrich, and Peri (1980)	Not plotted
Lakeville-Sobrante 230 KV Transmission Line Archaeological Sensitivity Map (letter report)	2663	Damon (1980)	White Slough Unit, American Canyon Unit, Tolay Creek Unit
Vallejo Freeway, Napa River Bridge to Route 80, 10-Sol-37 P.M. 8.0/11.4, 10204-028241	5063	Soule (1974)	White Slough Unit
Slaughterhouse Point Development, Environmental Evaluation and Impact Assessment-Cultural Features	5092	Davis (1977)	Slaughterhouse Point/American Canyon Unit, White Slough Unit
An Archaeological Survey of the Milleric/Larson Property, 27000 Burndale Road, Sonoma County, California (MS 7835)	5739	Haney (1982)	Wingo Unit, Ringstrom Bay Unit
Archaeological Survey of the Milleric/Larson Property, 27000 Burndale Road, Sonoma County, CA (letter report)	5774	Haney (1983)	Wingo Unit, Ringstrom Bay Unit
A Cultural Resources Study of Previously Unsurveyed Portions of the P.G. & E Lakeville-Sobrante 230 KV Transmission Line	6250	Roper and Frederickson (1983)	Tolay Creek Unit
Archaeological Survey Report for Upgrading a section of Route 37, 10-SOL-37 P.M. R8.0/R11.2, 10101-327000	6813	Adams (1984)	White Slough Unit
An Amended Cultural Resources Study for the Sonoma Valley County Sanitation District Partial Reclamation	6969	Stewart (1984)	Wingo Unit, Ringstrom Bay Unit
Projects Near Schellville, Sonoma County, CA			
Supplemental Archaeological Survey for the Proposed Sonoma Valley CSD Wastewater Reclamation Project, Sonoma Valley, CA	7364	Quinn (1985)	Ringstrom Bay Unit

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A Subsequent Archaeological Study for Sonoma Valley County Sanitation District Wastewater Processing Facilities, Sonoma Valley, Sonoma County, CA	7878	Gerike (1986)	Ringstrom Bay Unit
Archaeological Survey Report, Route 37 between the Napa River Bridge and Diablo Street in Vallejo, 10-SOL-37, P.M. R8.0/10.4	9110	Adams (1987)	White Slough Unit
An Archaeological Field Investigation of the Proposed Tolay Creek Winery Location; Sears Point, Sonoma County, CA	9156	Hayes (1987)	Tolay Creek Unit
An Archaeological Investigation of the Proposed Parking Area for Sears Point International Raceway, a Parcel of Approximately 55 acres on the East side of SR 121, Sonoma, CA	11121	Peron (1989)	Tolay Creek Unit
Archaeological Survey Report for a Portion of Route 121, from Sears Point to near Schellville, Sonoma County, CA, 04-SON-121, P.M. 0.0/9.2 04-12980G	12038	Dondero (1990)	Tolay Creek Unit
Archaeological Evaluation of the Vallejo Municipal Marina Mitigation Area, Napa County, California (89-45)	12058	Flynn (1989)	White Slough Unit, American Canyon Unit
First Addendum Archaeological Survey Report for a Portion of Route 121 near Schellville, Sonoma County, CA	17543	Dowdall (1995)	Tolay Creek Unit
Archaeological Reconnaissance, Napa River and Oat Hill Sanitary Landfill Area, Napa County, California	17582	Archaeological Consulting & Research Serv. (n.d.)	White Slough Unit, American Canyon Unit
Historic Properties Survey Report for the Proposed Widening and Placement of Concrete Median Barriers along State SR 37 between Tolay Creek and Mare Island, CA-Son/Sol-37	18369	Hayes, Morton, and Reynolds (1995)	Sonoma Creek Unit, Tolay Creek Unit
CA Dept. of Transportation Negative Archaeological Survey Report, Proposed Rehabilitation of Portions of the San Pablo Bay National Wildlife Refuge, south of SR 37 in Solano County.	18449	Hayes (1996)	Sonoma Creek Unit
Cultural Resource Report for the Tolay Creek Restoration Project, San Pablo Bay National Wildlife Refuge, Sonoma County, CA	19539	Valentine (1996)	Tolay Creek Unit
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Table 3-11. Previously recorded cultural investigations in the vicinity of the NSMWA.

Report Title	NWIC File #	Author (Date)[1]	Area(s) Covered by the Study
Acres, Located to the West of State SR 29			
Historic Properties Inventory for the Proposed City of American Canyon, S Napa River Tidal Slough + Floodplain Restoration Project	23924	Jordan and Carrico (2001)	White Slough Unit, American Canyon Unit
A Cultural Resources Survey of the Dickson Ranch Property near Sears Point, Sonoma County, CA	30485	Beard (2005)	Tolay Creek Unit
Records Search Results for T-Mobile Project, BA-10924: Across from 726 Catalina Circle, Vallejo, Solano County, CA 94589 (letter report)	33118	Losee (2007)	White Slough Unit, American Canyon Unit
Survey Reports within 1/4-mile of the Project Area			
Appraisal of the Archaeological Resources of the Napa River (Trancas Road to Edgerley Island) and Three Potential Reservoir Areas in the Napa River Basin	4	Fredrickson (1967)	Huichica Creek Unit
Archaeological Impact Evaluations, Rts 29 & 121, Slough Bridge, Napa County, CA	8	King, T. (1973)	Southern Crossing Unit
An Evaluation of the Archaeological Potential of the Area to be Modified by the Expansion of the Napa County Airport	41	Fredrickson (1974)	Green Island Unit
An Archaeological Reconnaissance of Buena Vista Winery Properties, Ramal Road, Sonoma and Napa Counties, CA	186	Fredrickson (1975)	Huichica Creek Unit
Archaeological Impact Evaluation: Proposed Sewage Pipeline, Napa to American Canyon, Napa County, CA	326	King, T. (1974)	White Slough Unit, American Canyon Unit
Preliminary Archaeological Reconnaissance of the Proposed Napa Meadows Subdivision, American Canyon, Napa County (letter rpt)	1144	Jackson (1977)	White Slough Unit, American Canyon Unit
Cultural Resources Field Report, App. 24395, Huichica Creek, Beaulieu Vineyards, Rutherford, CA	1406	Sheeders (1979)	Huichica Creek Unit
A Cultural Resources Survey of Five Napa River Disposal Sites	1908	Rudo (1980)	Southern Crossing Unit, /Bull Island (not in project area)
Cultural Resources Investigation of Operating Projects, Napa River Basin	2154	Brandt (1980)	Huichica Creek Unit, Green Island Unit
An Archaeological Assessment of the Sonoma Valley County Sanitation District Disposal Alternatives, Sonoma County, CA	2407	Eisenman (1981)	Ringstrom Bay Unit
Cultural Resources Overview of the Airport North Industrial Area, Napa County, CA	2435	Baker (1980)	Southern Crossing Unit
Archaeological Recon. of the Napa Industrial Park Project, Airport No. Industrial Area	2547	Salzman (1981)	Southern Crossing Unit
An Archaeological Survey of a Proposed Subdivision, A.P. #68-160-01, 243+/- Acres near Sears Point, Sonoma County, CA (letter report)	5803	Flaherty and Werner (1983)	Tolay Creek Unit

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Report Title	NWIC File #	Author (Date)[1]	Area(s) Covered by the Study
Archaeological Element of the Environmental Assessment of the United States Navy Homeporting Study, Mare Island, CA	6559	Roop (1984)	Mare Island (naval shipyard) (not in project area)
Archaeological Reconnaissance of the Zunino Property & the Dept. of Fish and Game Tract near American Canyon, Napa County, CA	8851	Baker (1986)	White Slough Unit, American Canyon Unit
An Archaeological Invest. of a 9.18 Acre Parcel at 2480&2500 Green Isl. Rd, Napa, CA	10579	Peron (1989)	Green Island Unit
An Archaeological Investigation of the Proposed Parking Area for Sears Pt Inter-national Raceway, a Parcel of Approx. 35 Acres at Hwys 37 & 121, Sonoma, CA.	11057	Peron (1989)	Tolay Creek Unit
Archaeological Archival Study for the City of Santa Rosa Wastewater Project Alternatives: Bloomfield Reservoir Site, Laguna Wetland Restoration Study Areas, Ocean Pipeline Alignment, & the South County Alternative/Lakeville Pipeline…	12123	Jordan (1990)	Tolay Creek Unit
Archaeological Survey and Evaluation for the Napa Sanitation District Master Plan Update, Napa County, CA	12429	Mikkelsen, Berg, and Bouey (1991)	Green Island Unit, Southern Crossing Unit
Cultural Resources Invest. for the Port of Oakland Phase I Dredging, CR Evaluation	12439	Chavez (1990)	Green Island Unit
A Cultural Resources Evaluation of the Cline Cellars Property, Sonoma County, CA (letter report)	12671	Roop (1991)	Wingo Unit
An Archaeological Investigation of a Portion of a Los Carneros Irrigation Conveyance Project near Cuttings Wharf, Napa County, CA	13560	Psota (1992)	Huichica Creek Unit
Archaeological Survey Report, Application 29852, C. Mondavi and Sons, a Limited Partnership, Napa County	13622	Soule (1992)	Huichica Creek Unit
Archaeological Survey of 2 Sites for Proposed Solid Waste Transfer Sta., Napa County, CA	14137	Loyd (1992)	Southern Crossing Unit
An Archaeological Study for a 94.14-acre Portion (APN 060-100-24) of Sears Point Raceway, Sonoma County, CA	15781	Jablonowski (1994)	Tolay Creek Unit
Mare Island Conceptual Reuse Plan, Historic and Prehistoric Resources Element	16059	Dept of Defense (1994)	Mare Island (naval shipyard) (not in project area)
Cultural Resources Study for the Napa Carneros Pipeline Project, Napa County, CA	16063	Origer (1994)	Southern Crossing Unit
Historic Resource Evaluation Report on Former Napa Valley Railroad Line, 04-NAP-29 P.M. 22.2-28.4 04226-111330	16849	King, G. (1986)	Southern Crossing Unit
Archaeological Recon. of the Proposed American Canyon Sanitary Landfill Site (letter report)	17581	Jackson (1978)	White Slough Unit, American Canyon Unit
Historic Survey of Mare Island Naval Complex, Final Rpt	17786	Cardwell (1985)	Mare Island (naval shipyard) (not in project area)

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Report Title	NWIC File #	Author (Date)[1]	Area(s) Covered by the Study
Mare Island Archaeological Resources Inventory, First Complete Draft	17792	Roop and Flynn (1986)	Mare Island (naval shipyard) (not in project area)
Prehistoric Archaeological Context Statement and Site Prediction Model, Mare Island Naval Shipyard, Vallejo, CA	18036	Allan and Self (1996)	Mare Island (naval shipyard) (not in project area)
Predictive Historic Archaeological Sites Model for Mare Isl. Naval Shipyard, Vallejo, CA	18112	Maniery and Baker (1995)	Mare Island (naval shipyard) (not in project area)
A Cultural Resources Study for the Sears Point Raceway, Sonoma County, CA	19455	Ferneau (1997)	Tolay Creek Unit
Archaeological Survey Rpt, 10-SOL-37, PM 8.89/8.94 CU 10-168, Retrofit of Bridge	19753	Levy (1995)	White Slough Unit
Archaeological Survey Rpt, 10-SOL-37, PM R7.073/ 7.352 CU 10-168, Retrofit of Brig.	19754	Levy (1995)	Mare Island (naval shipyard) (not in project area)
Archaeological Survey Rpt, 10-SOL-37, PM R7.388/8.012 CU 10-168, Retrofit of Bridge	19755	Levy (1995)	Mare Island (naval shipyard) (not in project area)
Cultural Resources Report for the Napa Marsh Unit (Cullinan Ranch) Tidal Restoration Project, San Pablo Bay National Wildlife Refuge, Solano County, CA	19760	Valentine (1997)	Napa River Unit
Cultural Resource Survey Report, Application 30252 & 30253, Beckstoffer Vineyards	20790	Soule (1994)	Huichica Creek Unit
Cultural Resource Survey Report, Application 29593, Dr. Joseph G. Roche	20802	Soule (1998)	Tolay Creek Unit
Archaeological Investigations at CA-SON-227&CA-SON-2226, Sears Pt Raceway, Sonoma County, CA	21688	Origer and Beard (1998)	Tolay Creek Unit
A Cultural Resources Inventory of the Napa Airport Master Environmental Assessment Area, Napa County, CA	22041	Flynn, Roop, and Melander (1983)	Green Island Unit, Southern Crossing Unit
A Cultural Resources Evaluation of the Proposed Viansa Master Plan, Sonoma County, CA	22894	Chattan (2000)	Wingo Unit
A Cultural Resources Evaluation of the Lands of Buena Vista Winery, 24500 & 24600 Ramal Rd, Near Schellville, Sonoma County, CA	23794	Chattan (2001)	Ringstrom Bay Unit
Cultural Resources Assessment for Sears Point Cell Tower Site (letter report)	24603	Reutter (2002)	Tolay Creek Unit
Revised Predictive Archaeological Model for Mare Island, Vallejo, Solano County, CA	24604	Maniery (2000)	Mare Island (naval shipyard) (not in project area)
Historic Property Survey Report for the SR 37/Mare Island Inter-change Project, Vallejo, Solano County, CA SR 37/KP R11.4 to 13.4	27319	Beard (2002)	Mare Island (naval shipyard) (not in project area)
A Cultural Resources Survey of the Proposed Cross-Country and Downhill Bike Tracks at Infineon Raceway, Sonoma County, CA	29816	Quinn and Origer (2004)	Tolay Creek Unit

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Final EIS/EIR, White Slough Flood Control Project, State Clearinghouse #2001072029	32342	U.S. ACOE (2001)	White Slough Unit
Survey Reports within the Project Area			
An Archaeological Survey of Possible Dredge Spoil Disposal Sites for the Napa River Channel Improvement Project	89	Moratto (1974)	Huichica Creek Unit, Southern Crossing Unit
Archaeological Assessment of the Sonoma Valley Reclamation Project, Sonoma County, California	278	French and Frederickson (1976)	Ringstrom Bay Unit
Cultural Resource Assessment of the Napa-American Canyon Wastewater Reuse Program	1200	Peak & Associates (1978)	Huichica Creek Unit
A Preliminary Cultural Resources Study of the Lakeville-Sobrante 230 KV T/L Project Area	1834	Eisenman, Gerike, and Goodrich (1979)	White Slough Unit, Sonoma Creek Unit, American Canyon Unit
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Lakeville-Sobrante 230 KV Transmission Line Archaeological Sensitivity Map (letter report)	2663	Damon (1980)	White Slough Unit, American Canyon Unit, Tolay Creek Unit
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Slaughterhouse Point Development, Environmental Evaluation and Impact Assessment-Cultural Features	5092	Davis (1977)	American Canyon Unit, White Slough Unit
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Archaeological Impact Evaluation: Proposed Sewage Pipeline, Napa to American Canyon, Napa County, CA	326	King, T. (1974)	White Slough Unit, American Canyon Unit
Preliminary Archaeological Reconnaissance of the Proposed Napa Meadows Subdivision, American Canyon, Napa County (letter rpt)	1144	Jackson (1977)	White Slough Unit, American Canyon Unit
Cultural Resources Field Report, App. 24395, Huichica Creek, Beaulieu Vineyards, Rutherford, CA	1406	Sheeders (1979)	Huichica Creek Unit
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Archaeological Survey and Evaluation for the Napa Sanitation District Master Plan Update, Napa County, CA	12429	Mikkelsen, Berg, and Bouey (1991)	Green Island Unit, Southern Crossing Unit,
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Archaeological Survey Report, Application 29852, C. Mondavi and Sons, a Limited Partnership, Napa County	13622	Soule (1992)	Huichica Creek Unit
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An Archaeological Study for a 94.14-acre Portion (APN 060-100-24) of Sears Point Raceway, Sonoma County, CA	15781	Jablonowski (1994)	Tolay Creek Unit
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Historic Resource Evaluation Report on Former Napa Valley Railroad Line, 04-NAP-29 P.M. 22.2-28.4 04226-111330	16849	King, G. (1986)	Southern Crossing Unit
Archaeological Recon. of the Proposed American Canyon Sanitary Landfill Site (letter report)	17581	Jackson (1978)	White Slough Unit, American Canyon Unit
Historic Survey of Mare Island Naval Complex, Final Rpt	17786	Cardwell (1985)	Mare Island (naval shipyard) (not in project area)
Mare Island Archaeological Resources Inventory, First Complete Draft	17792	Roop and Flynn (1986)	Mare Island (naval shipyard) (not in project area)

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Prehistoric Archaeological Context Statement and Site Prediction Model, Mare Island Naval Shipyard, Vallejo, CA	18036	Allan and Self (1996)	Mare Island (naval shipyard) (not in project area)
Predictive Historic Archaeological Sites Model for Mare Isl. Naval Shipyard, Vallejo, CA	18112	Maniery and Baker (1995)	Mare Island (naval shipyard) (not in project area)
A Cultural Resources Study for the Sears Point Raceway, Sonoma County, CA	19455	Ferneau (1997)	Tolay Creek Unit
Archaeological Survey Rpt, 10-SOL-37, PM 8.89/8.94 CU 10-168, Retrofit of Bridge	19753	Levy (1995)	White Slough Unit
Archaeological Survey Rpt, 10-SOL-37, PM R7.073/ 7.352 CU 10-168, Retrofit of Brig.	19754	Levy (1995)	Mare Island (naval shipyard) (not in project area)
Archaeological Survey Rpt, 10-SOL-37, PM R7.388/8.012 CU 10-168, Retrofit of Bridge	19755	Levy (1995)	Mare Island (naval shipyard) (not in project area)
Cultural Resources Report for the Napa Marsh Unit (Cullinan Ranch) Tidal Restoration Project, San Pablo Bay National Wildlife Refuge, Solano County, CA	19760	Valentine (1997)	Napa River Unit
Cultural Resource Survey Report, Application 30252 & 30253, Beckstoffer Vineyards	20790	Soule (1994)	Huichica Creek Unit
Cultural Resource Survey Report, Application 29593, Dr. Joseph G. Roche	20802	Soule (1998)	Tolay Creek Unit
Archaeological Investigations at CA-SON-227&CA-SON-2226, Sears Pt Raceway, Sonoma County, CA	21688	Origer and Beard (1998)	Tolay Creek Unit
A Cultural Resources Inventory of the Napa Airport Master Environmental Assessment Area, Napa County, CA	22041	Flynn, Roop, and Melander (1983)	Green Island Unit, Southern Crossing Unit
A Cultural Resources Evaluation of the Proposed Viansa Master Plan, Sonoma County, CA	22894	Chattan (2000)	Wingo Unit
A Cultural Resources Evaluation of the Lands of Buena Vista Winery, 24500 & 24600 Ramal Rd, Near Schellville, Sonoma County, CA	23794	Chattan (2001)	Ringstrom Bay Unit
Cultural Resources Assessment for Sears Point Cell Tower Site (letter report)	24603	Reutter (2002)	Tolay Creek Unit
Revised Predictive Archaeological Model for Mare Island, Vallejo, Solano County, CA	24604	Maniery (2000)	Mare Island (naval shipyard) (not in project area)
Historic Property Survey Report for the SR 37/Mare Island Inter-change Project, Vallejo, Solano County, CA SR 37/KP R11.4 to 13.4	27319	Beard (2002)	Mare Island (naval shipyard) (not in project area)
A Cultural Resources Survey of the Proposed Cross-Country and Downhill Bike Tracks at Infineon Raceway, Sonoma County, CA	29816	Quinn and Origer (2004)	Tolay Creek Unit
Final EIS/EIR, White Slough Flood Control Project, State Clearinghouse #2001072029	32342	USACE (2001)	White Slough Unit

[1] Full references can be found in the Cultrual Resources Report for the Napa Sonoma Marshes Wildlife Area Land Management Plan (URS 2008)

During the inspection, DFG personnel accompanied the URS archaeologist to locations where prehistoric resources have been previously recorded. At these locations, a visual spot check was performed, and notes and photographs were taken of the locations where prehistoric resources have been previously recorded. These resources included CA-NAP-230 (the shellmound site originally recorded by Nelson, located on Green Island and relocated in 2005), CA-SOL-269 (a lithic (stone tools and debitage) scatter at Slaughterhouse Point originally recorded by N.C. Nelson in 1907 and re-recorded in 1960 and 1977), and CA-SON-227, a prehistoric site originally recorded by Nelson in 1907 and revisited in 1997 by the Anthropological Studies Center at Sonoma State University.

Based on the reconnaissance level inspection, no archaeological remains were identified and no previously recorded sites were relocated. Although dark, organic soils were observed at the location of previously recorded site CA-NAP-230, no shell, chert, or obsidian flakes (as noted in the 2005 primary record) were observed during the survey. CA-SON-227 is now located within Infineon Raceway grounds and the main raceway office has been built upon the mound. No evidence of CA-SOL-269 was identified on the surface within the project unit; however, the area is now contained within a residential housing development. Over a century of development, topographic features referenced by Nelson appear to have entirely disappeared as the areas have been developed for agricultural and industrial (i.e., salt mining) use. Additional disturbances have come from road and building construction. It does not appear that the LMP has the potential to affect any archaeological resources within the project units. However, if one (or more) of the shellmound sites were encountered as a result of future project activities, it would potentially be eligible for inclusion in the NRHP under Criterion D for its potential to yield important data on shellmounds in the North Bay area.

3.10 RECREATION AND PUBLIC USE

This section describes the numerous recreation and public use activities and opportunities available at the NSMWA. The NSMWA is currently a “Type C” wildlife area that does not require any special permits or fees for general entry (USACE 2004a). The NSMWA lends itself to many public uses. Recreation and public use include hunting, fishing, wildlife viewing, boating, environmental, and scientific programs, nature observations, photography, and hiking. DFG estimates from visitor log books that approximately 1,000 people use the site annually, including 600 hunters and 400 visitors engaged in other natural activities (Jones and Stokes 2004a, 2004b]). (**Figure 13**) shows the main publicly accessible land areas and facilities. Camping and trailers are not allowed within NSMWA.

3.10.1 Buildings and Structure for Public Use

3.10.1.1 Headquarters

The DFG maintains limited constructed facilities for the NSMWA. The NSMWA Field Headquarter, as known as the North Bay Field Office, is located at 2148 Duhig Road. It consists of a former Dairy Farm and its associated structures. The main building has employee housing, a conference room, offices, a restroom, and a kitchen. Other buildings include: a bunkhouse used for office space, a garage used as a maintenance shop, a pole barn used for vehicle and equipment storage, and a barn used for storage and special events as needed. The DFG has developed an outdoor amphitheater area with a fire pit and barbecue that can be used for school groups, educational events, etc. Additionally, the DFG has set up a native plant nursery on-site.

Public meetings are held at the headquarters conference room. It is anticipated that educational and interpretative program would be developed as part of NSMWA's management program.

3.10.1.2 Roads and Parking

Highways and local public paved roads provide access to the some areas of the NSMWA. Currently, no gravel roads or unimproved dirt roads are available in the NSMWA for public vehicle access, except for Tolay Creek (northern portion) (**Figure 13**). Tolay Creek Unit (southern portion) and the southern portion of Napa River Unit can be accessed via SR 37 pullouts. Ringstrom Bay Unit can be accessed by taking SR 12 to Ramal Road, then taking Ramal Road to the designated parking area. Access to the Huichica Creek Unit can be gained by taking SR 12 to Duhig Road, then by turning left on Las Amigas and right on Buchli Station Road to its terminus. White Slough Unit can be accessed by taking SR 29 to Meadows Drive and Catalina Circle. The Green Island Unit can be accessed by taking SR 29 to Green Island Road. The remaining areas are accessible by boat via the Napa River, Sonoma Creek, Napa Slough, Hudeman Slough, and other tributary sloughs.

A limited number of parking lots or pullouts are located along various parts of the roads and provide access to the trails, hunting, and fishing sites (**Figure 13**). DFG manages two public parking lots for recreational access at the Huichica Creek Unit and the northern portion of the Napa River Unit, one north of the salt ponds at the end of Buchli Station Road and the other at the end of Milton Road (Jones and Stokes 2004a, 2004b). The Buchli Station Road parking lot has a voluntary check station where visitors can fill out "use cards" related to their activities (USACE 2004a). The southern marsh areas can be accessed through the three parking lots off SR 37: a paved parking lot at southeast corner of Pond 1, the Sonoma Creek Unit parking lot on Skaggs Island Road, and the newly created Lower Tubbs Island parking lot that is located at the north east corner of South Tolay Unit. Other parking areas available to the public include Ringstrom Bay Unit parking area off Ramal Road, the parking area along Millerick Road at the northwestern corner of Wingo Unit, Tolay Creek parking lot across from Sears Pt. Raceway, and

Napa Sonoma Marshes Wildlife Area Land Management Plan

FIGURE 13

Public Access

Management Units with hunting designations

- Closed to hunting
- Open to hunting

Other

- Ecological Reserve, closed to hunting (DFG, current)
- Ecological Reserve (proposed after restoration monitoring is complete in 2024), closed to hunting (DFG, future)

- Parking
- Trailhead
- Boat launch
- Headquarters
- Dirt road
- Paved road
- Highway
- Closed to public
- Power line
- Railroad

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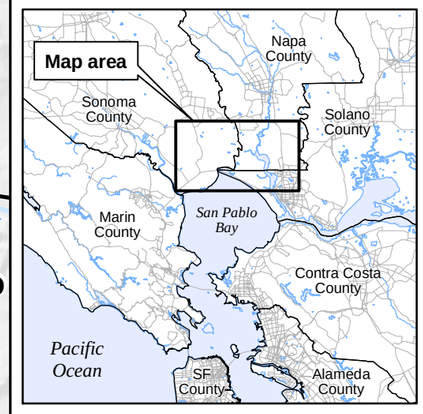

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Sonoma Creek
Millerick Road
Wingo Unit
Wingo Unit (Camp 2)
Ringstrom Bay Unit
Ramal Road
Poehlman Road
Huichica Creek
Duhig Road
Duhig Road Headquarters
Las Amigas Road
Bayview Avenue
Carneros Creek
Buchli Station Road
Cuttings Wharf Rd
Stanly Lane
Soscol Ferry Road
Southern Crossing Unit (Stanly Ranch)
Milton Road
Bull Island (DFG)
Fagan Marsh Ecological Reserve (DFG)
Ponds 9, 10 (Napa Plant Site)
South Airport Road
Green Island Road
Green Island Unit (Napa Plant Site)
Hudeman Slough Enhancement Wetlands (SVCSD)
Hudeman Slough
Third Napa Slough
Huichica Creek Unit (HCU)
HCU Fly Bay
HCU Pond 8
HCU Hudeman Slough (at Napa Slough)
HCU Ponds 7, 7A
Coon Island Unit
Napa Slough
Napa River
Napa River Unit (NRU) Ponds 6, 6A (Little Russ Island)
Devil's Slough
NRU Ponds 4, 5 (Russ Island)
NRU Little Island Farms
NRU Pond 2
NRU Pond 1A
NRU Pond 1
NRU Pond 2A (Banty Island)
NRU Pond 3 (Knight Island)
Dutchman Slough
Cullinan Ranch (USFWS)
Skaggs Island (US Navy)
Skaggs Island Road (closed to public)
Sonoma Creek Unit (West End)
Tolay Creek Unit (North)
Infineon Raceway
Tolay Creek Unit (Tubbs Island)
Tolay Creek
Tolay Creek Unit (at Midshipman Slough)
Sears Point (Sonoma Land Trust)
Tubbs Island Setback (USFWS)
Lower Tubbs Island
San Pablo Bay National Wildlife Refuge (USFWS)
San Pablo Bay
American Canyon Unit
American Canyon Road
American Canyon Creek
AMERICAN CANYON
Eucalyptus Drive
White Slough Unit
Meadows Drive
Chabot Creek
Austin Creek
VALLEJO
121
37
29
12

the South Crossing Unit parking area off Stanley Lane. An access road, a 42-space parking lot, and restrooms are planned for the Green Island Unit.

Currently, most of the parking lots in the NSMWA have no improved facilities. The Buchli Station Road parking lot in Huichica Creek Unit is the only parking lot with pit toilets.

3.10.1.3 Boat Ramps

Two public boat ramps just outside of the Napa River Unit allow reasonably good boat access to the sloughs. One is at Cuttings Wharf, and the other is on Hudeman Slough (**Figure 13**). Green Island Road in the Napa River Unit is open to the public and provides access to the Napa River levee for fishing. When restoration of the southern section of the Green Island Unit is completed then access to a boat ramp for hand launching of watercraft will be available for public use.

Example Regulatory Sign

3.10.1.4 Public Access

The NSMWA provides two sections of unpaved, improved trails (totaling 4.13 miles) for walking and hiking (**Figure 13**): one at the northeast corner of the Ringstrom Bay Unit and one in the Tolay Creek Unit (southern portion), south of SR 37. Approximately 76 miles of non-drivable unimproved roads or levees that were constructed around the former salt ponds and along the sloughs, creeks, and rivers in NSMWA have also been used as trails by visitors participating in activities such as hunting, fishing, and wildlife viewing. When restoration of the southern section of the Green Island Unit is completed, access to additional trails is anticipated (**Appendix E**).

3.10.1.5 Signs

The NSMWA uses four categories of signage to regulate public use and access. The categories are: directional, regulatory, informational, and interpretive signs. Directional signs are located at various intersections inside NSMWA to help visitors navigate within the area. Regulatory signs at parking lots inform visitors of allowable activities and restrictions within the respective area. Signs such as the NSMWA nameplate adjacent to SR 37 and Meadows Drive (White Slough Unit) inform visitors of the existence of the NSMWA. Two interpretive signs/kiosks are located near the Buchli Station Road parking lot in Huichica Creek Unit and provide interpretation of wetland habitats and wildlife at the site. Other interpretive signs are located in the Ringstrom Bay Unit, Wingo Unit, and Sonoma Creek Unit parking lots (Taylor 2008b) and are planned for a future trail along eastern edge of Pond 7/7A.

3.10.2 Existing Recreational and Educational Activities

3.10.2.1 Hunting

Hunting is one of the main forms of recreation currently available within the NSMWA. Designated hunting areas are shown on **Figure 13**. Authorized species include waterfowl, coots and moorhens, quail, snipe, rabbits, pheasants, and doves (CDFG 2007b). September 1 is the traditional beginning of the hunting season and is the opening day of dove season. Waterfowl season usually opens in mid October and runs until the end of January or early February. Hunt days are Saturdays, Sundays, and Wednesdays during open seasons for authorized species, except that doves and rabbits may be hunted daily during the dove season (Wyckoff 2000). There are no day use charges to the licensed hunter or visitor (CDFG 2007b). An estimate of 600 hunters annually uses the area from September through January for dove, pheasant, rabbit, and waterfowl hunting.

A Waterfowl Hunter Scans a Seasonal Pond for a Place to Set Decoys

Pond 2 was leased to Can Duck Club for waterfowl hunting and fishing until the lease expired in July 2007. Several duck club facilities, including a small clubhouse on the northwestern corner of Pond 2, a caretaker's house in the northwestern portion of Pond 1, and several hunting blinds remain on the property (Jones and Stokes 2004a, 2004b). There are approximately 16 duck blinds scattered on Pond 2. Approximately eight blinds are permanent and made of concrete. The rest of the blinds are wooden and need to be replaced approximately every 5 years. The blinds are located a couple of hundred yards from the edge of the pond. Currently, the hunting blinds are not maintained by DFG and may be torn down in the future if issues associated with improper use of the hunting blinds arise (Huffman 2007b). There is also a privately owned duck club on the northeastern portion of the island on which Pond 6A is located. The property contains a simple structure for club member recreational use.

Ken Border of DFG holds a striped bass caught in Pond 1 of the Napa River Unit (Photo by: Tom Huffman, DFG)

3.10.2.2 Fishing

Fishing is a popular activity throughout the sloughs, Sonoma Creek, Napa River, and ponds within the NSMWA (Wyckoff 2000). Most of NSMWA falls within the Ocean and San Francisco Bay District and is regulated by the Sport Fishing Regulations.

Although the NSMWA has no improved facilities on-site, facilities for public fishing are found at Hudeman Slough Launch Ramp, and Cutting's Wharf fishing access in Napa (USACE 2004a). Facilities include parking, launching ramps, docks, and restrooms at some locations. Where bank or levee access is available, fishing takes place along the rivers, creeks, sloughs, and southern Ponds 1 and 1A.

3.10.2.3 Wildlife Viewing

The NSMWA is recognized as one of the better places in the North Bay to observe wildlife because of the variety of habitats and species present. Bird watching and hiking are allowed throughout the site. Many species of birds and mammals may be observed in the NSMWA. Visitor may see a multitude of birds of prey, shorebirds, waterfowl and other migratory birds with over 160 known species have been identified within the area. Mammals that can be seen in NSMWA include river otters, beavers, raccoons, coyotes, deer, squirrels, and rabbits.

Wildlife viewing blind

A wildlife viewing blind was constructed in the Huichica Creek Unit with funding from Acacia Winery. The blind is a cozy, roofed hut overlooking a fresh-water pond that shorebirds, ducks, and geese increasingly use.

3.10.2.4 Environmental Education and Interpretative Programs

The NSMWA Field Headquarters has some facilities for work groups, but there is no regular use (Taylor 2008a). DFG has developed an outdoor amphitheater area with a fire pit and barbecue that can be used for school groups, educational events, etc. Additionally, the DFG has set up a native plant nursery on-site.

For the past several years, Acorn Soupe, a local school, has been doing restoration

A school group led by Americorps plant oaks along Huichica Creek (photo by: Tom Huffman, DFG)

projects in the Huichica Creek Unit (Taylor 2008a). They obtain access permission from the DFG every year.

3.10.2.5 Research and Scientific Studies

Several studies have been conducted in the NSMWA. Currently there is no centralized library or database for tracking this information. A brief description of the major research studies is provided below.

The Integrated Regional Wetland Monitoring (IRWM) Pilot Project is a CALFED-funded interdisciplinary research effort to examine wetland restoration outcomes in the North Bay and Delta and to aid in developing effective and informative monitoring strategies through a comprehensive and real-time approach. Field sites for this project include Coon Island, Pond 2A, and Pond 3 of the NSMWA.

An interdisciplinary research study was conducted USGS scientists and scientists from PRBO, UC Davis, and Humboldt State University, to provide science support for the Napa-Sonoma Marsh Restoration Project (Takekawa et al. 2000; Takekawa et al. 2005).

Warner (2000) conducted a research study in the Napa-Sonoma Marsh complex to determine the physical processes that control the circulation patterns of water and suspend sediment in the tidal slough network.

Coon Island Unit was used by the U.S. Army Corps of Engineers and the DFG for preliminary data gathering to identify marsh vegetation by remote sensing (CDFG 1975).

3.10.3 Proposed Recreational and Public Access Facilities

The Napa Plant Site Restoration (NPSR) Project at the Green Island Unit would utilize upland areas for site access, public access facilities (**Appendix E**), and DFG personnel housing (URS 2006a). The site access road has been realigned and raised. Gates on the site access road would be used to restrict public vehicle access to daylight hours. A DFG employee would reside in the existing residential housing on Green Island. The DFG warden and Napa County sheriffs would patrol the site on a regular basis. Public access and recreation facilities, including a primary staging area for parking, picnicking, restrooms, and boat launching centered on the barge channel, would be constructed at the Napa Plant Site (**Appendix E**). Hand launching of non-motorized watercraft (e.g., canoes, kayaks) would be possible at the existing boat ramp to the barge channel. Connections to bicycle access trails on Green Island Road and future connections to other outlying areas would be facilitated. A perimeter trail would be developed to support both pedestrians and cycling. The trail has the potential to connect with a regional trail network. The NPSR project team is working with the City of American Canyon to coordinate trail connection opportunities near the end of Eucalyptus Road (**Appendix A**). Smaller nature trails with interpretive signage would also be developed. In the long term, DFG is considering creating an environmental interpretive center on the property. The site access road and upland staging area

presents a unique opportunity for locating an interpretive center adjacent to the Napa River and its wetlands.